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Operating Features of the L Street Station

THE EDISON ELECTRIC ILLUMINATING CO. OF BOSTON MAKES A THOROUGH STUDY OF ITS POWER GENERATION; POWER EQUIPMENT, ARRANGEMENT AND OPERATING ROUTINE ARE DESCRIBED HERE

TO A GREAT EXTENT, the wonderful growth of the central station is due to the efficient methods of apparatus employed in the power plant. The selection of apparatus is usually the work of the designer, and when once installed and turned over to the operating force, the burden is shifted and the success or failure of the plant will lie in the hands of the operators.

The Edison Electric Illuminating Co., of Boston, is the outgrowth of a number of electric companies who at one time or another furnished electricity to customers in and around Boston. The growth of the company has been rapid but steady and to those interested a study of each branch of its activities would prove profitable for the company's work has been history making and success has followed its efforts in all directions.

Readers of Practical Engineer are interested more particularly at this time in the operation of the company's most modern power plant, and since the boiler room presents more chance for variation in operation than any other part of the plant, we will spend a little

FIG. 2. VIEW IN THE BOILER ROOM

time in a study of its methods and equipment found essential for most economical operation.

The L Street Station

What is known as the L Street Station is located in South Boston and furnishes the entire alternating current output of the company. It is approximately 2 mi. from the heart of the city and 43 mi. from the extreme limits of the territory which it serves. The entire station consists of 2 sections radically different in their equipment, the older section representing what was considered modern 15 or 20 yr. ago, while the newer section is brought and kept up to date with new equipment as the demand warrants the installation of more machinery. These sections are tied together electrically through transformers, but otherwise are operated entirely separately. As the equipment of the new section is much more economical than that in the old, the latter is used as a standby. We will, therefore, turn our attention to the new plant.

In this case, a separate building is provided and the plant is built on the unit system so that each turbine is fed by the boilers nearest it in the boiler room. When this plant was laid out it was calculated that it would require 8 boilers to supply the steam necessary for each turbine and provision was made for an ultimate equipment of 12 turbine units each having a capacity of 5000 kw. or more. As power plant practice has advanced, it developed that the boilers can be worked at a higher load so that the space actually required for the boilers does not come up to that allowed for them. This throws the original plan out somewhat and the last tur-

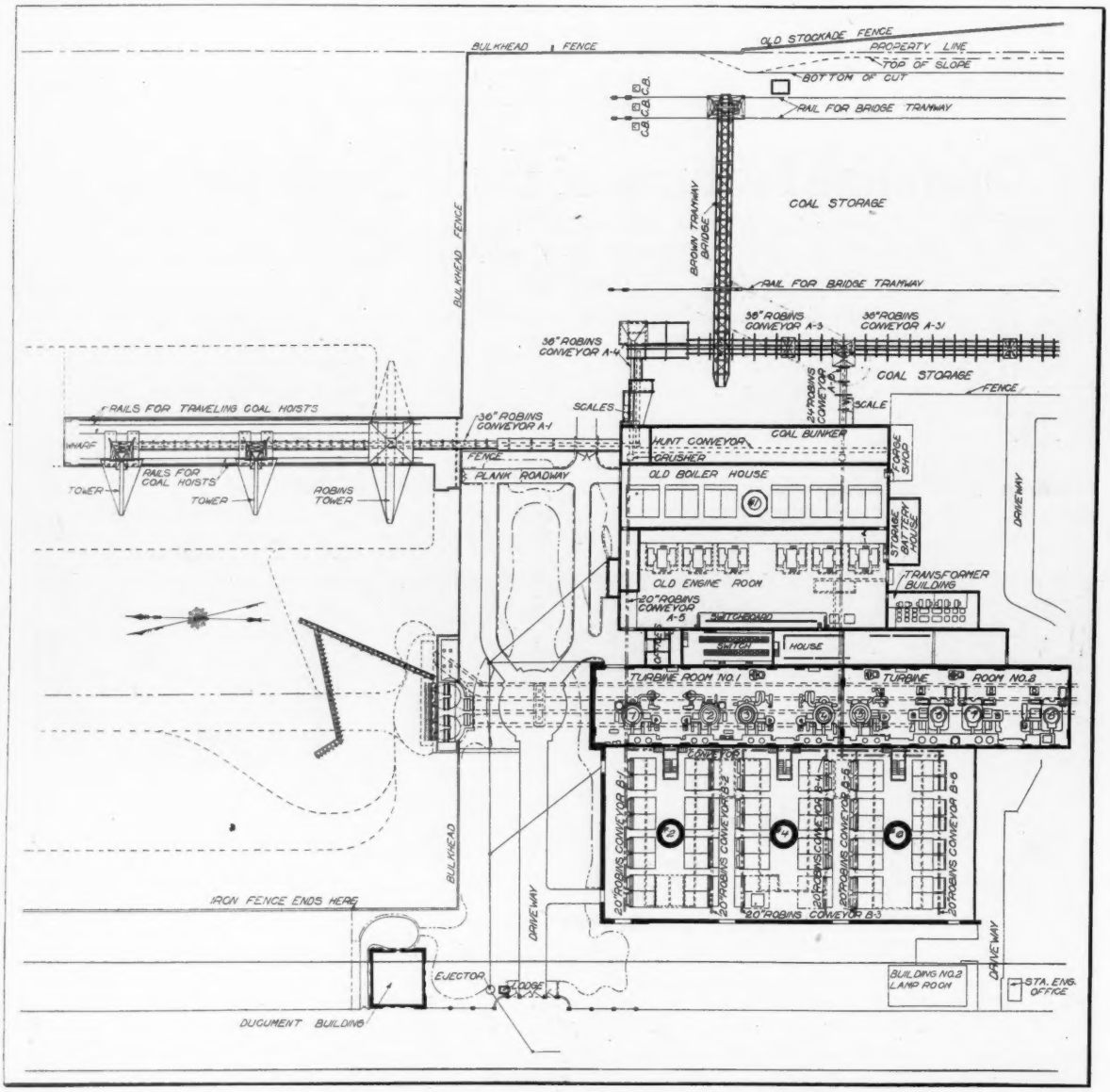


FIG. 1. GENERAL PLAN OF THE L STREET STATION, SO. BOSTON

bine unit installed, No. 8, which has just recently been put into operation, as well as No. 7, overhang the boiler room, which made it necessary to put in an additional steam header to furnish steam for the new unit at a minimum of transmission loss.

In the Boiler Room

Steam is generated in 48 2-drum B. & W. boilers, each rated at 512 hp. They are arranged in 6 rows of 8 each and each 2 rows are placed back to back and are served by 1 stack 16 ft. in diameter and 250 ft. above the foundation. Under 40 of these boilers are placed Murphy stokers with dutch oven furnaces; the other 8 have an older type stoker, which will probably be replaced in time when the load on the plant demands greater boiler capacity.

The settings of the boilers are the standard suspension type with 2 boilers to each setting; the baffling is also standard for 3 vertical passes. The bridge wall, baffles and furnace lining are of fire brick, the front of the setting of white tile, other parts common building brick.

It is customary to operate these boilers at about 135 per cent of their rating on non-peak loads. Although, under test conditions, the highest efficiency has been obtained when running at 100 per cent, from a practical standpoint, 135 per cent load has proved most successful. During the peak loads the boilers are, at times, required to run up as high as 300 per cent of their rating. It has been found that the more the boilers are forced the greater will be the superheat, and through tests it has been proved that a rise of 12 deg. in superheat increases the efficiency of the turbine 1 per cent. The load factor during the off-peak period averages between 45 and 65 per cent. To aid the firemen in the operation of the plant, a load indicating sign in the boiler room is operated from the switchboard and during peak loads each boiler is expected to carry 1800 to 2000 kw.

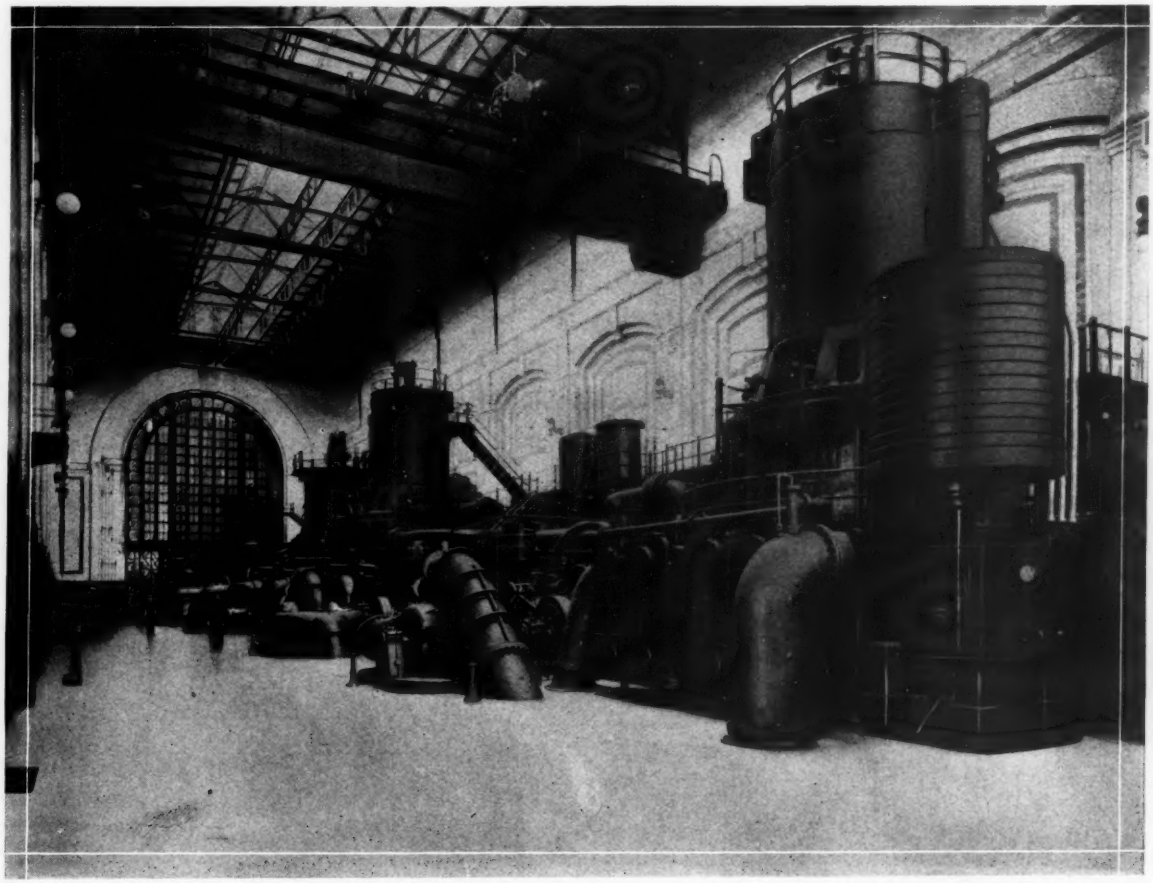


FIG. 3. GENERAL VIEW OF THE TURBINE ROOM SHOWING UNITS NOS. 1, 2, 3 AND 4, THE OTHER UNITS ARE ON THE OTHER SIDE OF THE PARTITION IN THE BACKGROUND

The projected area of the grate surface is 90 sq. ft., and the heating surface is 5120 sq. ft. in each boiler, giving a ratio of 1 to 56.9. The average air space in Murphy grates is 40 per cent.

A trial installation of automatic water regulators of the continuous feed type are placed on 12 of the boilers and the water columns on these are of the common type with high and low water alarm. To carry over the peak load in the most economical manner, the level of the water is raised during periods of low load, thus storing energy for the load to come.

Fusible plugs are placed according to Massachusetts boiler rules, 6 in. from bottom of drum in front pass of the boiler.

Each boiler drum has 2 feed water pipes; one enters the front and ends 4 ft. from the front in a bell mouth discharging toward the rear. This is the connection ordinarily used and is the discharge of the feed pumps, one being provided with each turbine. The other connection is the discharge from the injectors and enters the rear head at one side, runs about 4 ft. into the drum, crosses to the other side and then turns and discharges toward the rear in the direction of the water circulation. Each boiler is equipped with 1 injector.

Two blowoff connections are made to the mud drum of each boiler. In each connection are 2 Nolan blow-off valves; they discharge into a blowoff tank. The boilers are blown down during the noon hour on Tuesdays and Fridays, lowering the water level about 2 gages. The water is changed every month and every 2 months the boiler is out of service for inspection and cleaning. The gages and water columns are blown down once during each watch, i.e., 3 times a day.

Safety valves blowing off saturated steam are located on a cross pipe between the drums. There are 4 of these, each 4 in. The superheater also has a safety valve attached to it. All these valves are of Ashton make and are set to blow at 205 lb.; they are tested once a week.

There is a perforated dry pipe in each drum through which the steam goes to the superheater, which is of the B. & W. make, located between the first and second passes under the drum, and is designed to give 150 deg. of superheat, having 867 sq. ft. of heating surface, but is ordinarily operated at 125 to 150 deg., depending on the load carried. The superheater is started flooded, but the water is blown out when the steam reaches 25 lb. pressure.

New River coal with a heat value of about 14,750 B.t.u. is used, and it is found that best results are had when the thickness of the fuel bed is about 4 in. The average combined efficiency of the furnace and boiler is about 70 per cent.

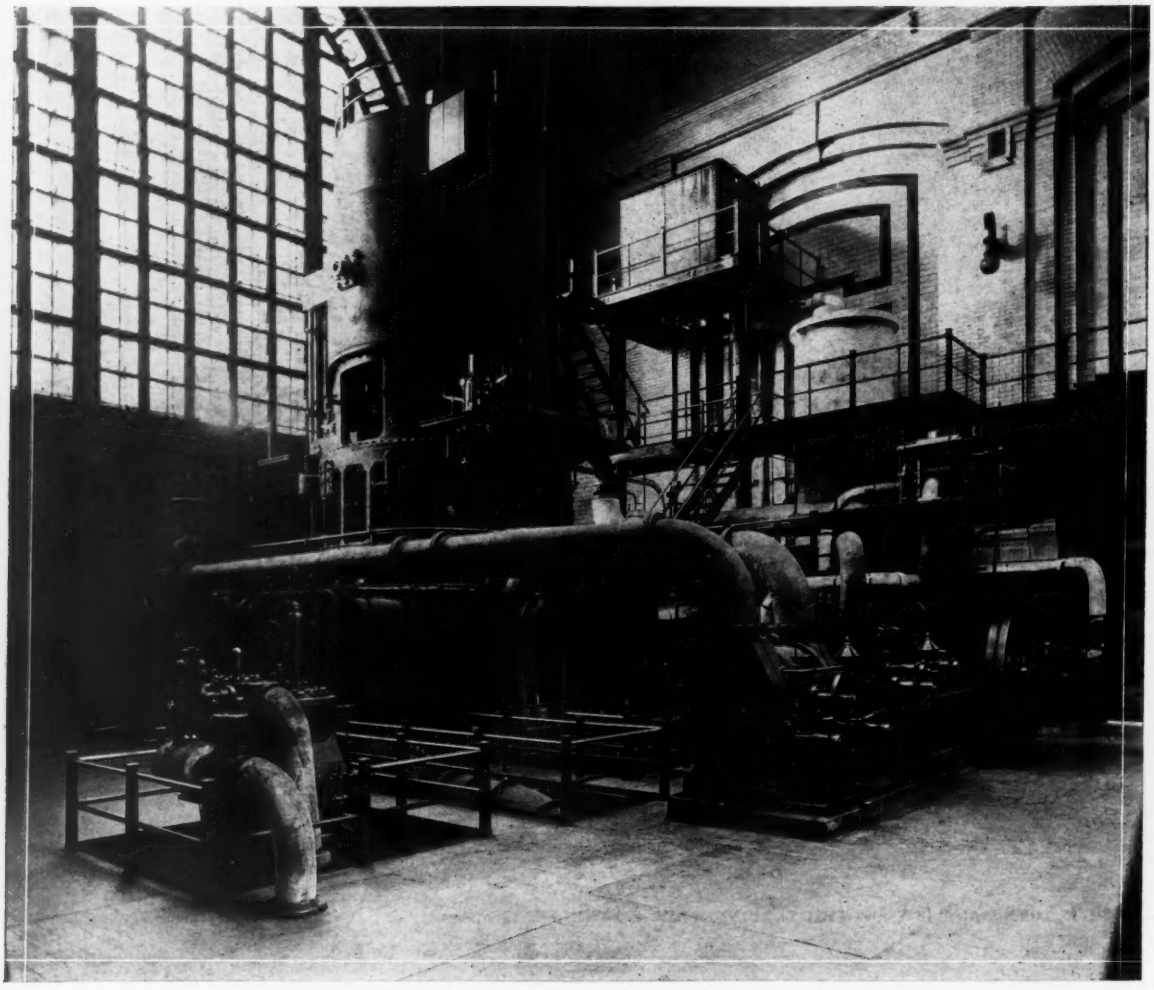


FIG. 4. GENERATING UNIT NO. 8, 2-STAGE VACUUM PUMP AT THE RIGHT

Draft over the fires is maintained at from 0.2 to 0.3 in., depending upon the load, by a Blaisdell-Canady balanced draft system the effectiveness of which is shown by a draft gage on each boiler. During heavy peak loads, when it is necessary to force the boilers greatly, an Argand blower is used to help the draft.

For studying furnace and tube conditions, a Bailey Furnace Indicator and Boiler Output Gage has been installed on one of the tubes. This consists essentially of a steam flow meter and 2 draft gages, one showing the

air pressure between the atmosphere and the furnace, the other the differential pressure between the furnace and the boiler side of the damper. These 3 indications are recorded upon 1 chart, and when the fire is in proper condition for the load being carried, all of the pen arms are in a coincident position; any deviation in the shaft from that which is proper for the load being carried is shown by the position of the pen arm so that the fireman knows exactly what is the difficulty with his fire or condition of his tubes. In addition to the combustion indicator steam flow meters give definitely the load upon each boiler.

floor of the coal yard with a span of 155 ft., and a 72-ft. cantilever. The hoist on the bridge has a 2-ton bucket and can make a complete trip in 1 min. The coal can be taken up from any part of the yard by this bridge and returned to the belt conveyors to be sent to the bunkers.

The entire capacity of the coal yard is 70,000 tons, but that under the belt trestle is only 20,000 tons. To provide against loss through spontaneous combustion, numerous hydrants are available, but coal can be frequently turned over by the bridge to avoid this.

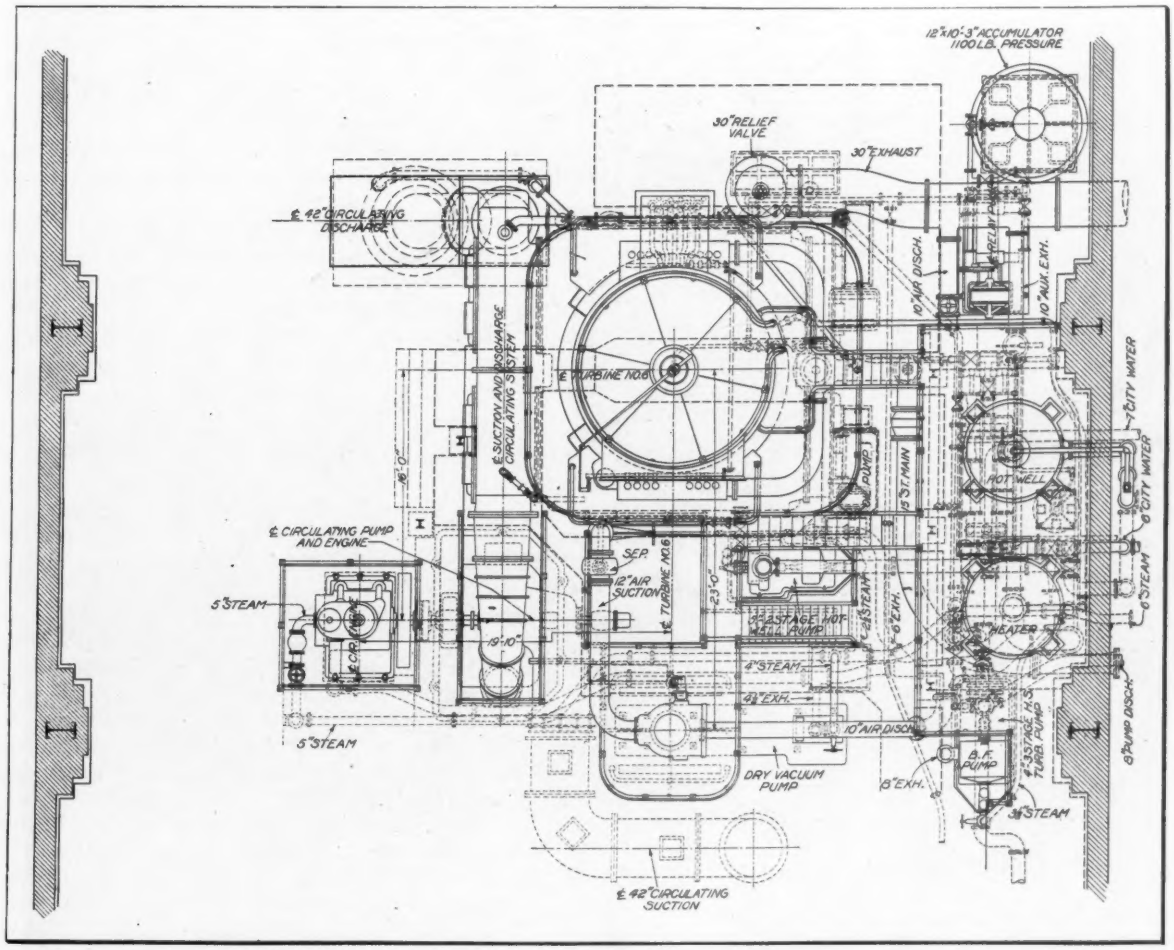


FIG. 5. PLAN OF NO. 6 UNIT WHICH IS TYPICAL OF THE PLANT

Coal Handling System

As previously stated, New River coal is used, usually run-of-mine grade, though some shipments of nut and slack have been received. This comes to the plant in barges delivered to the company's private dock, which has a 25-ft. depth of water at low tide. Here 2 coal towers are erected; one of these has a bucket of 1 ton capacity, the other 1½ ton. Both deliver to a 36-in. Robins belt conveyor system.

From the towers, the coal is conveyed either to a Brown bridge over the coal yard, or through crushers to the boiler bunkers. The bridge is 60 ft. above the

Coal is weighed on automatic scales as it is brought to the boiler room from the barge or yard. Cross belts deliver the coal to the boiler bunkers, each of which has a capacity of 44 tons, sufficient to run the boiler it serves 40 hr., at a combustion of 20 lb. of fuel per sq. ft. of grate surface per hr. From the bunker, a hand operated valve controls the feed to a weighing hopper of 3600 lb. capacity or direct to the furnace hopper. The weighing hopper is hand operated and used only when the boiler is being tested as the automatic scales weighing all coal to the boiler room give sufficient data for the operating records.

Make-up water only is measured as it goes to the feed water heaters, this being done by city water meters. As a great share of the water used for feeding purposes is condensate from the hot-wells of the surface condensers, the exact amount of water evaporated in each boiler is not kept in the daily record. Steam, however, being measured by an indicating flow meter, the fireman knows exactly what each boiler is doing at any instant.

In the record of the plant, the following temperatures are kept: Outside atmosphere; make-up feed water to the heater which averaged about 65 deg., and water leaving the heater about 180 deg. Nearly all of the feed

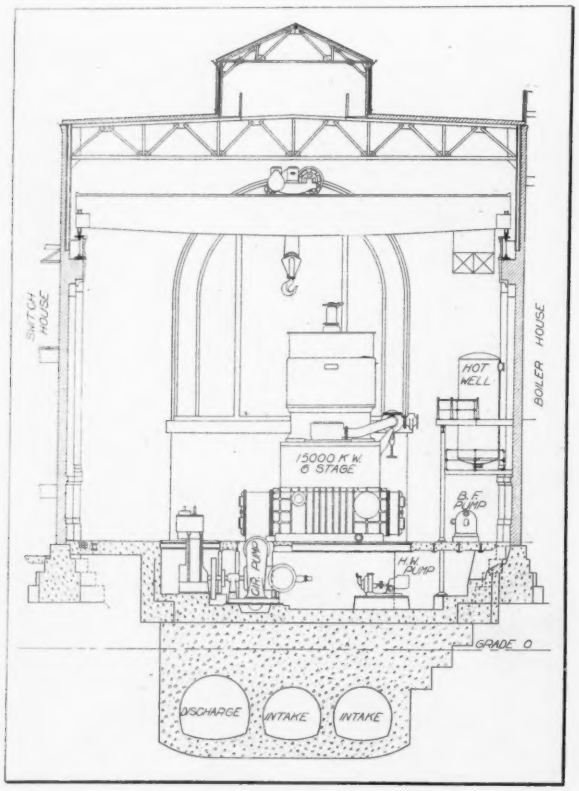


FIG. 6. SECTIONAL ELEVATION OF TURBINE ROOM

water heaters are of the closed type upon which ½ lb. of steam pressure is carried, and when the exhaust from the auxiliaries is not sufficient for heating the water to 180 deg., steam is bled from the first stage of the turbine to make up the deficiency. Furnace temperature is taken during tests, and runs at 2500 to 2600 deg., and as flue gas temperature changes considerably with the rate of combustion it is not taken as part of the daily record, but tests show it to range between 425 and 525 deg.

The plant is equipped with CO_2 recording instruments which may be connected to any of the boilers when it is desired to find out the kind of work the furnace is doing.

For the most part, water fed to the boilers is condensate from the surface condensers, but in addition some city water is used and a boiler compound made by Dearborn Chemical Co., is used to prevent scale. The city water here, however, is not considered bad, but what impurities it contains makes a hard scale unless the water is treated. It has been found almost needless to run a turbine through the tubes, which, however, is done occasionally as a precaution. To prevent the water in the boiler from becoming concentrated with scale forming material the boiler is emptied once each month.

Until recently, the soot has been blown from the tubes by means of hand blowers, but a Bayer soot blower has been installed on one boiler for experiment.

Beneath the stokers is a reinforced concrete ash hopper from which ashes are discharged into wagons which are hauled directly into the basement. From the soot pit behind the bridge wall is another chute which also discharges into ash wagons.

When a boiler setting shows indications of air leaks, the flue gases are analyzed by means of the CO_2 recorder and the setting is gone over with a wick lamp or torch to ascertain the location of the air leaks. Asbestos cement is used for stopping up all cracks in the boiler walls and baffles.

Periodic inspection of all boilers is rigidly enforced in this plant to discover any defects or possible weaknesses in the boiler proper, and its mountings. Once each month each turbine is subjected to an operating test which will show up any decrease in efficiency and indicate where improvements can be made.

The Turbine Room

Generating equipment consists of 8 vertical Curtis turbines, which vary considerably in construction, having been installed at various times during the past 13 yr.

Old Nos. 1 and 2 were duplicates, the capacity of each being 5000 kw. and the speed 514 r.p.m. New Nos. 1 and 2 are 12,000 kw. at 720 r.p.m. These are served by Worthington surface condensers of 20,000 sq. ft. area. Sea water is used for cooling purposes, being pumped through the condenser by a Worthington 30-in. volute centrifugal pump direct connected to a Flemming-Harrisburg engine. The dry vacuum pump is a Worthington angle type 12 by 24 by 18 in. Water of condensation is fed to a National feed water heater, which is of the closed type, by a motor-driven 4-in. centrifugal pump and from the heater the water discharges to a hot well, from which it is delivered to the boilers by a duplex pump, 17 by 12 by 15 in.

Units Nos. 3 and 4 each have a capacity of 7500 kw., with auxiliaries similar though not duplicates of those for No. 1. Other units are of later design and show changes which have taken place during these few years in turbine practice. Number 5 is a 12,000-kw. unit. The step lubricant is water, the pumps all give 1150 lb. pressure, but this is baffled to 800 to 950 lb. for the various units. The condensate pump is turbine driven on the last 4 machines instead of motor driven.

Coming to the next 2 units, 6 and 7, we find considerable change in type and variation in auxiliaries from the former units. These have a capacity of 15,000 kw. each; the condenser has a surface of 25,000 sq. ft. The circulating pump is a Worthington but driven by an Atlantic vertical engine, while the dry vacuum pump is a Laidlaw-Dunn-Gordon, angle type. The step bearing pump for No. 7 is a Worthington, 14 by 3 by 18 in. The steam step pumps are supplemented by 3 motor-

driven triplex pumps which are automatically thrown in when the pressure drops below what it should be. At the time these units were installed, turbine driven auxiliaries had proved successful and we find them here for both boiler feed and condensate pumps.

The last turbine to be installed is No. 8, which has been in operation but a few months and represents the very latest in vertical turbine practice. The capacity is 15,000 kw., and the condensing surface furnished is 27,870 sq. ft. Circulating water is supplied by a Worthington 40-in. centrifugal pump driven by an Atlantic engine and has a capacity of 30,000 gal. per hour.

Condensing water for all of these turbines is taken from the harbor in 2 masonry conduits, each with a sectional area of 56 sq. ft., and protected from fish and trash by copper screens placed across the intake, 2 in series. The discharge pipe is 1 masonry conduit with a sectional area of 78 sq. ft. To keep the warm discharge water from recirculating through the condensers, a wing dam is built in the harbor between the inlet and outlet of the condensers.

The vacuum carried on the turbines is between 1 in. and 0.43 in. of the barometric reading, depending upon the temperature of the sea water.

FIG. 7. VIEW IN LOAD DISPATCHER'S OFFICE

The dry vacuum pump is of the 2-stage angle type, built by the Laidlaw-Dunn-Gordon Co., and runs at 90 r.p.m. The steam cylinder is 12 in. in diameter by 24 in. stroke; the air cylinders are each 31 in. diameter by 24 in. stroke, placed in tandem. The inlet valves to the low pressure cylinder are mechanically operated and the pump will maintain a vacuum within 0.1 in. of the barometric reading.

Another distinctive feature of the auxiliary equipment of No. 8 is the use of an open heater, closed heaters being used with all the others.

All the generators develop 3-phase, alternating current at 6900 v. and 60 cycles, but two have auto transformers for stepping to the 13,800 volt bus. There are 2 distribution pressures, 6900 and 13,800 volts.

Excitation is furnished by 3 motor-generator sets, each consisting of a 445-hp., 3-phase synchronous motor direct connected to a d.c. 125-v. generator.

A complete system of signals is in operation between the switchboard and the turbine room and the turbine operators receive their orders from the switchboard, as to the putting of generators into service. A load indi-

cator, visible from all parts of the generating room, is an aid to the operators as it gives them an opportunity to know how the load on the plant is going and prepare them for orders to come from the switchboard.

An important feature in the operation of these turbines is the test which is conducted upon each unit once a month; this is similar to a complete acceptance test and its object is to determine the best operating conditions and to maintain the units at their highest efficiency.

About once a year, the generating units are taken out of service and thoroughly cleaned.

Load Dispatcher's Board

An exceedingly interesting and new feature of this plant is the load dispatcher's board. This is a complete diagram of the distributing system of the company, showing the number of lines, voltage carried and permissible load on each line between generating and substations. Power house switches are shown by lights and substation switches by plugs. In case of a fault in any part of the transmission system, the board shows directly how the faulty line can be by-passed and thus serve customers from the substation affected without delay.

The load dispatcher is kept in touch with the workings of the entire distribution system by telephones, 2 separate lines running to each substation and generating plant. This system is found to be the most convenient for keeping tab on lines being repaired and eliminates considerable danger to repair men.

Electricity generated in the station has a voltage of 6900, this is transformed in part to 13,800 volts for distribution to substations, where it is again transformed to 2300/4000 volts for general distribution on a 3-phase, 4-wire system or converted into direct current for use in the immediate neighborhood.

(During the past few years, the attention of those in charge of the operation of power plants has been turned especially to the boiler room, with the result that many changes in common practice have taken place. With the object of presenting to our readers the methods adopted in the boiler rooms of the most efficiently operated plants of the country, a series of articles, of which the above is the first to be published, has been prepared after a study of conditions in various classes of power plants and will be presented in succeeding issues of Practical Engineer.—Editor)

On April 25, students of the Mechanical and Electrical Engineering Departments of the Ohio State University, began a trip which lasted through the week, spending 2 days in Chicago, 2 days in Milwaukee, and 1 day each in Gary and Detroit.

The object of the trip is observation of actual practice in shops and power plants, and each student is provided with a book discussing the things to be observed and noted, which is interleaved with blank pages for the observations. These pamphlets were prepared by Professors Magruder of the Mechanical Engineering Department, and Caldwell of the Electrical Engineering Department, and are a fine discussion, for the use of anyone making visits to plants, as to the points which he may well note, and upon which he should secure data.

Prevention of Soot Deposits on Outside of Boiler Tubes

By J. L. Armstrong and C. M. Wiley

IT is generally understood that the deposit of soot which accumulates on the outside of water tubes and the inside of fire tubes, or, in fact, any part of a boiler exposed to flames, due in most cases to dampness caused either by the firing of wet coal or the sweating of the boiler when idle and standing full of cold water, greatly decreases the efficiency of the boiler. In most types of boilers, soot is very difficult to remove by any mechanical means, as it sticks to the sheet or tubes and in time becomes exceedingly hard. In most boilers, it is difficult to reach most of this deposit and, in addition, the use of a steam soot blower increases the trouble, as, due to the dampness of the steam, that soot which is not removed becomes hard and as a result will not yield to any type of blower.

While more of this deposit may be removed by using an air blower, this cannot be recommended, as it is hard on boilers on account of the undue expansion and contraction caused by the cold air striking the hot sheets or tubes, and further, is dangerous, as it may cause a sheet or tube to rupture and explode.

It has been found that on the front bank of tubes of Stirling water-tube boilers where this deposit forms more readily than any other place on the boiler, by thoroughly cleaning the tubes by means of a scraper made of an old file and a wire brush and then painting the surface exposed to the deposit of soot with a mixture of graphite and water, the deposit of soot will be reduced to a minimum. This mixture, in the form of a thin paste, is painted on the tubes or sheets and then allowed to dry, after which the graphite is well rubbed into the pores of the metal by polishing, leaving a smooth, glossy finish which will not burn off and to which the soot will not adhere. After the first application the graphite is quite easy to apply.

We polish the tubes of our boilers every 30 days, when down for washing, and use the same grade of graphite as is used in the boilers as a scale preventive. This graphite is much cheaper than that prepared for lubricating purposes and is just as effective.

After 2 or 3 applications, the pores of the metal become thoroughly filled and the boilers could run for 30 days and still be perfectly clean. Before using graphite in this way, we could not run more than 4 or 5 days before the soot would form quite a deposit and at the end of 30 days, would find from ⅜ to ½ in. of soot on the front row of tubes.

This method is not applicable to all boilers nor to all parts of any particular boiler on account of the difficulty of applying, due to lack of room.

Care should be taken only to run rubber belts in the right direction. Several makes are marked with an arrow with this intent. If the belt is not so marked, it does not matter in which direction it is run. If a rubber belt is gashed down to the canvas, the decay of the core may be postponed by anointing the gash with a rubber solution.—Gas Power.

Valve Used on Large Dams of Federal Projects

OPERATED BY HYDROSTATIC PRESSURE. BY A. P. CONNOR

THIS is a description of a valve used on large dams of federal projects, such as the Roosevelt dam, to permit the water to flow through them when required. The valve is built on self-balancing principles, and is usually used in a size having a seat diameter of about 5 ft.

It is not an easy matter to understand this valve owing to the somewhat complicated path that the water passes through in operating the valve, so in order to make the matter as clear as possible the drawings have been treated liberally with arrows, notes and other indicating means.

and on the shaft is mounted a gear which engages with and operates another gear that turns in a thrust bearing, and also engages in a nut or threaded portion a movable sleeve. The turning of the last mentioned shaft moves the sleeve either towards or away from the needle valve shown in the drawings. This sleeve moves in another sleeve made of material of low frictional resistance. The first sleeve is adapted to close over the needle valve; and the needle valve is provided with a spring arrangement to enable it to withstand sudden shocks or jars.

This valve is attached to the piston or gate or closure of the main valve. The piston has the appearance of a

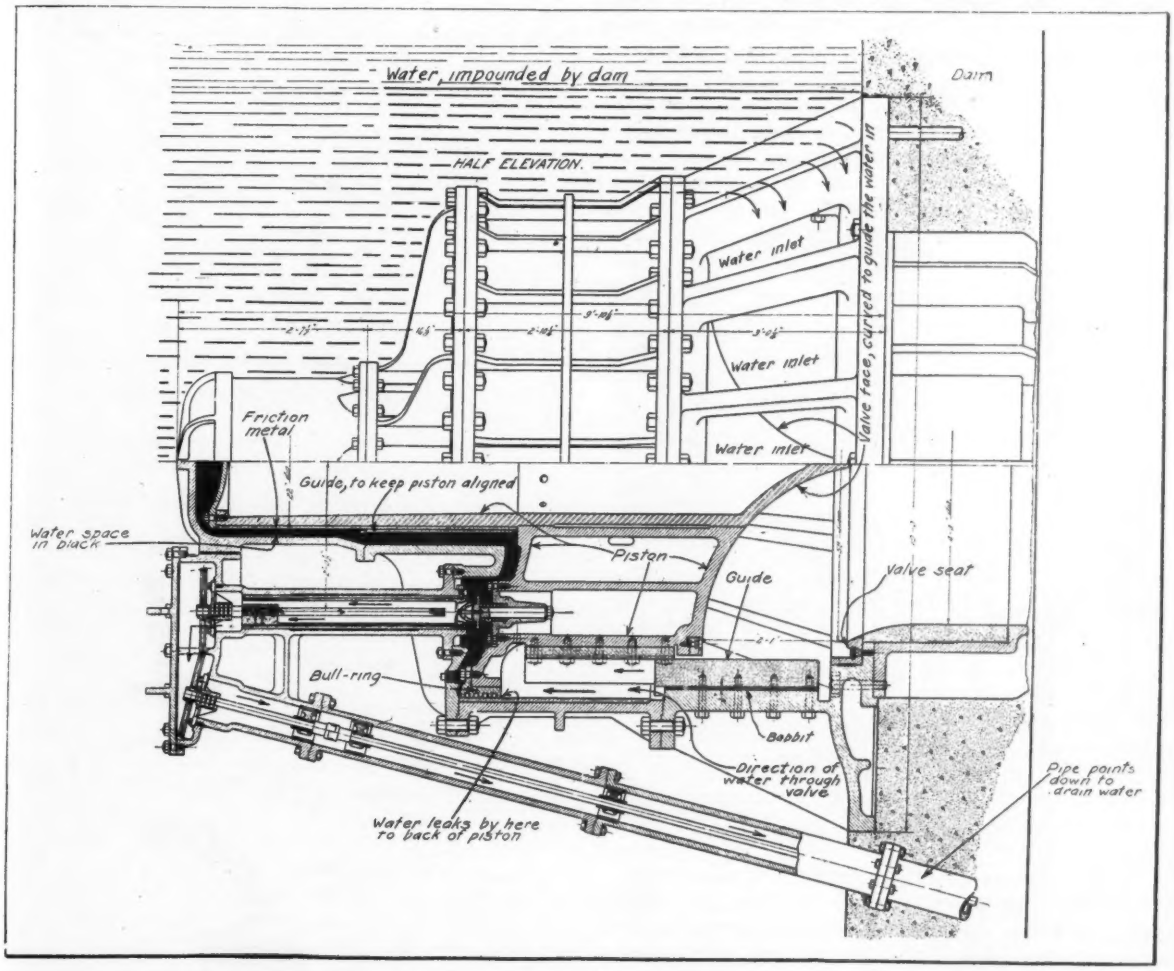


FIG. 1. HALF SECTION THROUGH A-A FIG. 3, VALVE OPEN, SHOWING POSITIVE CONTROL

The valve is operated entirely by water pressure, no other mechanical means push its gate on its seat. The valve is placed on the side of the dam on which the water is impounded and over a hole in the dam through which the water can pass to the other side of the dam.

In the drawings, will be seen the mechanism that causes the valve to work. This consists of a turning shaft, which may be operated by any suitable means,

large stem top, as can be noted from the cross-section. Its bottom face is convexed to the center, so as to guide the water through the valve towards the hole in the dam. The water enters the valve through the ribs shown supporting the casing of the valve proper. The seat of the valve is circumferential.

Water can get behind the piston by leaking past the bull ring, which is at the widest part of the piston. In

doing so, the water gets behind the whole piston, and occupies the space designated in black in the section of the whole valve.

When the valve is open, it occupies the position shown in Fig. 1, and the water passes through the valve by the rounded portion of the piston, that is adjacent to the dam wall. At the same time, water can pass up the side of the piston to the back of the valve. In such a case, there is lack of pressure on the front of the valve, owing to water flowing past it and not against it. The full static pressure of the water, however, is acting against the back of the valve, because it can act through the leakage past the bull-ring in this way. If there is nothing to relieve the pressure on the back, the piston or gate will be forced to a closing position. If the needle valve is closed by the sleeve covering it, there will be no outlet for this pressure except by pressing the valve piston forward. When the piston moves towards closed position, it takes the needle valve away from the sleeve, and the water behind the piston finds an outlet through the sleeve, into the gear casing, down the passageway containing the turning shaft, thence into a chamber in the dam, and then through an outlet into the river on the down-stream side of the dam. If the shafts and gears are turned so that the sleeve will be forced towards and close to the needle valve, the pressure will act on the piston and force it forward again. Therefore, to close the main valve, all that has to be done, is to keep moving the sleeve towards the needle valve.

To reverse the valve, the sleeve is caused to move in the opposite direction. That is, in closing the main valve, the sleeve is caused to recede from the needle valve, so that the pressure of water at the back of the valve will be expended by escaping into the sleeve, etc. The pressure of the water on the face or rounded portion of the valve, will then be sufficient to force the main valve open. If the sleeve is left stationary it will

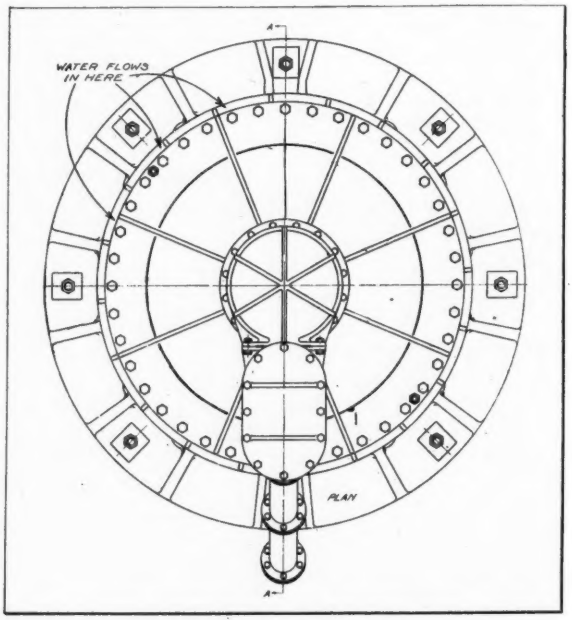


FIG. 3. PLAN OF VALVE

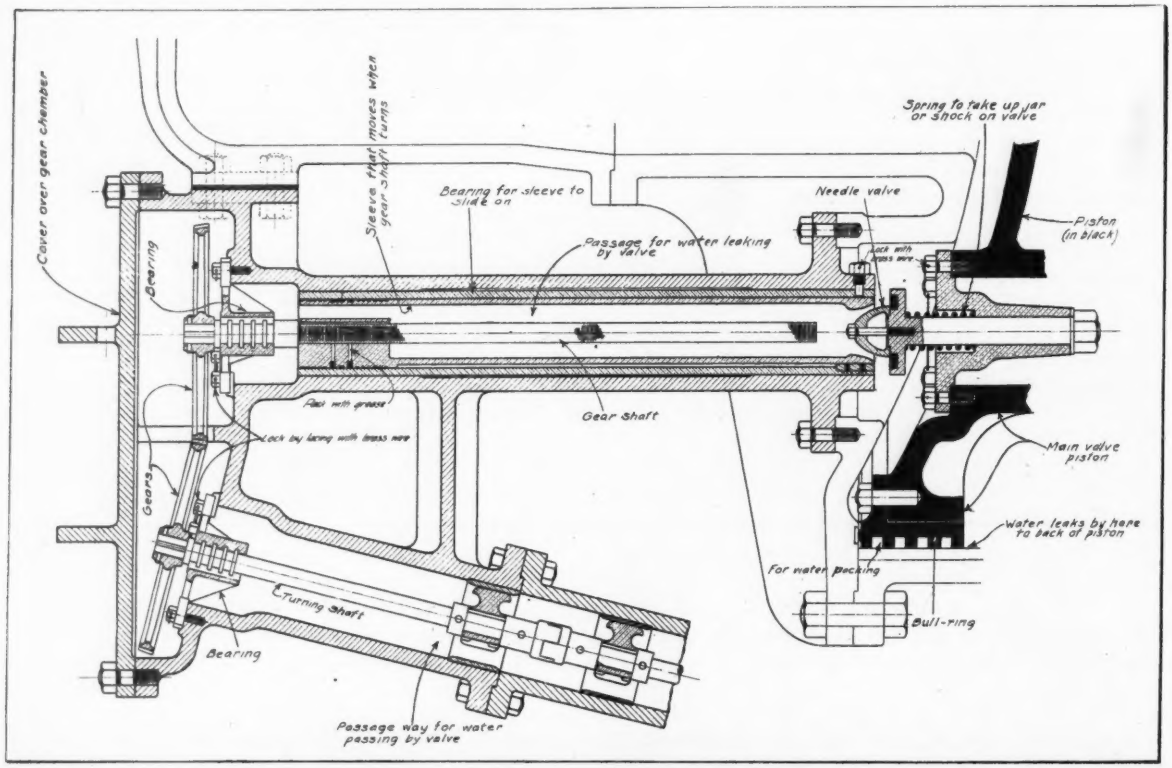


FIG. 2. NEEDLE VALVE AND CONTROL DETAILS

cause the main valve to remain stationary, because it will balance itself. This stopping can be readily seen, as the movement of the needle valve either way, with the piston, will cause the pressure to act for or against the piston as the case may be. The piston is arranged to permit the sleeve to be left open from the needle valve, in its most open position, in order to allow the water to pass freely out from behind the piston, out

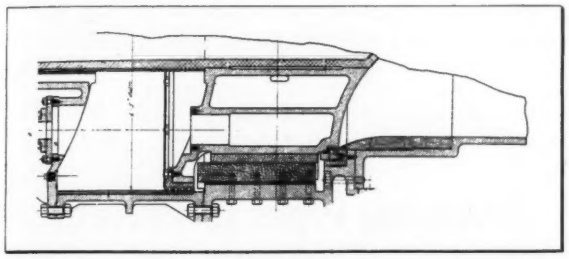


FIG. 4. VALVE CLOSED; NEEDLE VALVE DETAILS NOT SHOWN

through the sleeve and operating mechanism casings.

The valve is very simple, free from parts liable to get out of order, and under a slight head will close or open with great force owing to its large area that takes the water pressure.

In actual practice, it is usually necessary to provide some screen device to prevent debris from becoming lodged in the valve. This may be done by attaching such to the casing where the water passes into the valve.

Automatic Sprinkler

DRY-PIPE SYSTEMS; VALVES; PIPING; AIR SUPPLY; ALARMS. BY L. M. LEWIS

WHERE automatic sprinklers are placed in open or unheated buildings or where subject to freezing conditions such as in cold-storage vaults or rooms, the water must be excluded from the piping until a fire occurs. This is accomplished by placing in the pipe lines an automatic valve known as a dry-pipe valve.

FUNCTION AND DESIGN OF DRY-PIPE VALVES

WATER IS ADMITTED to the under or supply side of the valve while air pressure is maintained on the upper or system side of the valve. This is the same pressure as is confined in the distributing lines.

The opening of a sprinkler at any part of the system exhausts or reduces the air pressure on the valve, causing it to open and admit water into the system.

Present types of dry-pipe valves are of either the differential or the mechanical type. In the former, the air pressure acts upon a diaphragm of large area to overbalance the water pressure under the valve. This type necessitates maintaining an air pressure in proportion to the water pressure; that is, the higher the water pressure, the higher the pressure must be.

The mechanical type operates through a system of levers interposed between the main air and water clappers or between an auxiliary air clapper and the main water clapper. The air pressure required is constant regardless of the changes in water pressure. Figure 1 illustrates a dry-pipe valve of the mechanical type the levers of which operate between an auxiliary air clapper and the main water clapper, and, as may be seen, this valve has a full size, straight and unobstructed waterway.

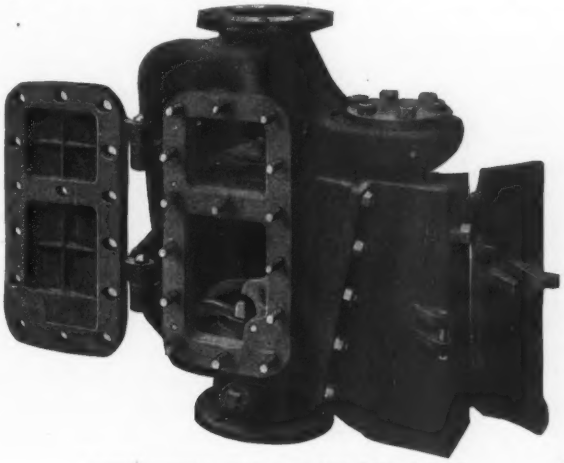
Automatic sprinkler systems should be so arranged that, preferably, not more than 300 sprinklers are placed on any one dry-pipe valve.

Although in some instances as high as 500 sprinklers may be placed on one dry-pipe valve, 300 is the largest number ordinarily allowed.

Buildings of 2 stories or more requiring over 500 sprinklers, should be divided horizontally into groups, each group being controlled by one or more dry-pipe valves. For example, in a 6-story building requiring 100 sprinkers per floor, the first, second and third floors would be supplied by one dry-pipe valve and the fourth, fifth and sixth floors by another.

DRY-PIPE VALVE HOUSE OR ENCLOSURE

THE DRY-PIPE valve should be placed as near the main riser as possible. Where exposed to cold, the valve should be located in an approved underground pit or enclosed in a room or closet of sufficient size to give, preferably, 30 in. free space on all sides of, and



MECHANICAL TYPE OF DRY-PIPE VALVE

above and below the valve. The enclosure should be such that the interior may be kept reasonably warm and dry, and should be heated by some means, such as by steam heater, lard-oil lantern, or by gas or electric heater. An additional automatic sprinkler should be placed in this enclosure for local protection.

Where it is possible or desirable to operate the system as a wet system in warm weather, or in the case of large risks, it is advisable to install the dry-pipe valve in a bypass and to place in the supply line an alarm check valve. Then if the dry-pipe valve is temporarily out of service the alarm check valves provide a means of securing an alarm upon the opening of a sprinkler.

AIR SUPPLY

TO SUPPLY the air pressure required for the dry-pipe system an electric or steam-driven compressor is recommended, but the electric-driven compressor is preferable. In some plants where only one valve is installed, the hand or belt-driven compressor may be used.

Where there are 2 or more boilers in a plant and one operated continuously, the use of the steam compressor is entirely satisfactory.

The air compressor should closely follow the sizes given in the table herewith:

	Capacity in Cubic Feet per Minute		
	Hand or Belt Driven	Steam	Electric
One dry pipe system subject to one fire	14 cubic feet	20 cubic feet	11 cubic feet
Not over two pipe systems subject to one fire	Not Advised	20 " "	11 " "
Three or more pipe systems subject to one fire	Not Advised	20 " "	20 " "

Connections to Dry-Pipe Valve

The method of connecting dry-pipe valves varies somewhat with each type used. Every manufacturer furnishes a complete description and cuts showing all supply and system connections, all alarm, air supply, test and drain connections and their location on the valve.

It is always desirable to secure a valve so constructed that all outlets for these connections are on the valve body. It insures proper and cheaper installations and ease of operation.

Alarms, Piping and Valves

Every dry-pipe valve should be provided with an alarm system to give instant notice of its operation and of the fire. Alarm systems are of 2 general types, mechanical and electrical. The mechanical alarm consists of a water wheel or motor connected by a shaft to a steel gong and is operated when the water passes through the valve to the sprinkler lines. The electric alarm consists of a circuit closer operated by the water as it passes to the sprinklers. This circuit closer is connected through batteries to electric gongs placed at convenient points in the building.

The spacing of sprinklers and the sizes of piping required for dry-pipe systems follow the tables and rules given in the previous article on wet-pipe system. It is, however, not out of place to state that on dry-pipe systems, sprinklers must always be placed in a vertical position.

Great care must be observed in installing the piping in a dry-pipe system to prevent air leakage, and to insure proper drainage at all points of the system. All piping in dry-pipe systems should pitch back to riser not less than ½ in. in 10 ft.

The requirements for longturn fittings and hangers are the same as for wet-pipe systems.

As few controlling valves as possible should be used in a dry-pipe system. Their location and design should follow the rules given for wet-pipe system.

Dry-pipe systems should be so arranged, if possible, that all pipe lines drain back to one main drip valve located at or near the dry-pipe valve. If conditions necessitate small or individual drip valves they should be conveniently located for inspection and test. Outlets of drip valves may be plugged, but no plugs without valves should be used.

Valves should be provided for testing height of priming water at dry-pipe valve. A 2-in. outlet should be provided on the dry-pipe valve under water clapper to test for pressure and volume of water supply under valve.

All dry-pipe systems must be tested to not less than 50 lb. of air pressure for 2 hr. and prove reasonably tight.

Underground Air Piping

Wherever pipe under air pressure is placed underground, it should be of wrought iron and should be painted with 2 coats of a good rust-proof paint, such as asphaltum or tar, one coat before pipe is laid and the final coat after being placed into position with all joints screwed tight.

All underground piping should be laid well below frost line.

Draining Pipes to Prevent Freezing

Various Simple Piping Arrangements by Means of Which Much Trouble May Be Avoided. By H. A. Jahnke

THERE are many pipes, valves and fittings broken in some plants during cold weather, due to lack of sufficient drainage of these pipes to prevent freezing. These pipes may be located outdoors or in rooms not heated during part of the cold season.

It is the writer's intention to illustrate and describe pipe connections which gave trouble and to explain how these troubles were remedied, as perhaps some reader may have had similar troubles and may thus profit thereby.

Considerable trouble was experienced with the piece of pipe freezing between the globe valve and tank shown in Fig. 1. As the room in which the tank and pipe is located is not heated during the night, the globe valve was closed at night so as to drain the pipe from this valve to the pump; but on very cold nights, the piece of pipe between valve and tank would freeze, causing delay and other troubles in the morning. To overcome this trouble a close nipple and angle valve were used in place of the globe valve and piece of pipe as shown in Fig. 2.

An office was heated by exhaust, or live steam when necessary, but was not heated during the night. The radiators and coils were connected as shown in Fig. 3, when the return from radiator and coil were run into a pressure tank, then to the sewer. There were 2 valves necessary on each radiator and coil to shut them off. At times the office employes would close both valves when it became too warm, but would forget to open them at night, with the result that the radiator or coil would be frozen the next morning, because the radiator or coil could not drain. To overcome this trouble a small hole was drilled through the disc of each valve so at night, should any of the radiators or coils be shut off, the water would drain out of it through the small holes in the discs, thereby preventing freezing of the radiator or coil.

In another case, a radiator on a cement floor would be frozen in the morning. Live and exhaust steam was used. After a few months, the steam would not go through the radiator some morning. Looking for the

cause, it was found that the cement floor had settled on the discharge side of the radiator which, in turn, lowered the return pipe so it formed a pocket, preventing the water from draining out of the radiator at night when the steam was shut off on the feed line. After the radiator was set level, there was no more trouble.

A water pipe was run a long distance and arranged as shown in Fig. 4. When this job was laid out, it was

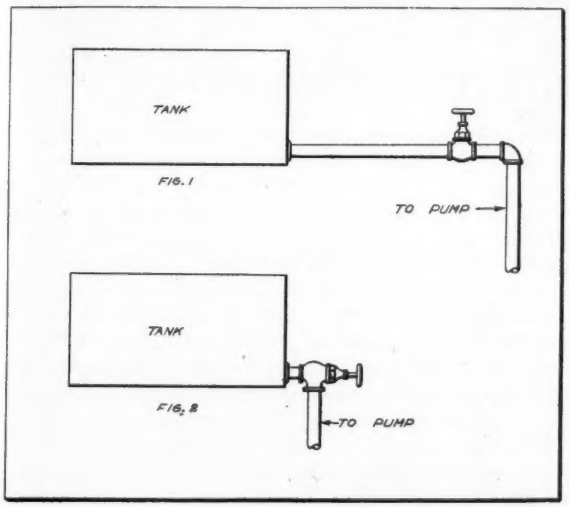


FIG. 1. TROUBLE CAUSED BY FREEZING OF PIPE BETWEEN TANK AND VALVE

FIG. 2. TROUBLE ELIMINATED BY USE OF SHORT NIPPLE AND ANGLE VALVE

thought that all that was necessary to drain the pipe was to close valve A and open B, but after the first cold night there was trouble the following morning with the pipe frozen. To overcome this trouble a drain valve was placed near valve A, as shown by the dotted lines, so that to drain the pipe valve A is closed while valve B and the drain valve are opened.

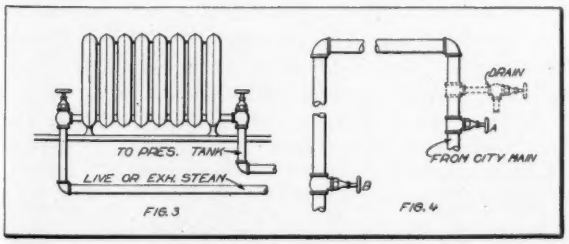


FIG. 3. WATER ENTRAPPED IN RADIATOR BY BOTH VALVES BEING CLOSED RESULTED IN CONSIDERABLE TROUBLE WHEN FROZEN

FIG. 4. BY EMPLOYING AN EXTRA DRAIN VALVE NO WATER ACCUMULATED IN LINE

Many blunders are made when arranging and connecting up pipes which are to be drained during cold weather. Pockets are formed at many points in a long line of pipe where there are not enough hangers to hold the pipe in a straight line, thereby forming a pocket. A long line of pipe that has to be drained should be inspected at times to see that no part of it has settled due to hangers getting loose; if so, it must be repaired in time to avoid trouble.

Another bad mistake some men make when thawing out a frozen steam or water pipe is to apply heat at a part of the pipe where there is no outlet for the expanding ice and water, with the result that something lets go. This may be the pipe or some fitting, whichever is the weakest part of the connection.

Pressure should never be applied to a pipe which is frozen at some point as there is danger of the pipe or fitting breaking before the ice is thawed out and, should this be a steam pipe, there is the additional danger of scalding someone.

To thaw out a steam or water pipe, start from some outlet, then work along until the frozen part of the line is clear of ice. In this way the expanding ice and water have room to expand toward the outlet.

The writer has sometimes cut the pipe to get an opening to save a valve or other expensive fitting from being broken by the expanding ice and water, then connecting the pipe again with a union or flange.

OUR ATTENTION has been called by E. H. Kirchner, President of the Minnesota State Association of Engineers, and connected with the Wisconsin Railway, Light & Power Co., of Winona, Minn., to a recent appointment of boiler inspector for that state. Matt Frisch has received the appointment, and Mr. Kirchner makes the following comments:

The law requires that every boiler inspector shall be a man of good moral character, qualified by experience in the construction of steam boilers, and shall have had at least 10 yr. of actual experience in operating steam engines and boilers.

It is claimed that Mr. Frisch is an Oak Ridge farmer, and that he has operated a threshing engine for 25 yr., but no records can be found of this, as the stubs of the engineers' certificates have been destroyed. Computing that a threshing engine operates from 6 to 8 weeks each year, and allowing 2 mo. as the maximum, the operation for 25 yr. would amount to 50 mo., which is equal to 4 yr. and 2 mo., as against the 10 yr. called for by the law. Also, the law requires a man experienced in the construction of boilers, and Mr. Kirchner states that Mr. Frisch was never inside a boiler, and that he, himself, admits it.

Another instance cited is that a boiler inspector drove into a farmer's yard and asked the aforesaid farmer how his boiler was. The farmer said, "I don't know; she ran all right when I stopped threshing last fall," so the inspector took out his certificate blanks, made out an inspection certificate without leaving the buggy, taking $3 for inspection fee from the farmer as he sat in his vehicle.

Mr. Kirchner writes further, that there are several boilers operating daily in Winona which are not inspected. He believes that it is not the fault of the Governor, who makes the appointment, but the fault of the law, and the condition will never be remedied until the public demands better service, and the appointment of efficient and capable men. Certainly conditions such as mentioned by Mr. Kirchner are lamentable, and tend to throw the entire matter of boiler inspection and the examination of engineers into disrepute.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Speed Control of Induction Motors*

PRIMARY CIRCUIT CONTROL; SECONDARY CIRCUIT CONTROL. BY B. G. LAMME

THE induction motor is primarily a constant-speed machine when supplied with constant frequency and voltage, which is the standard condition in all alternating current power service. When running at full speed, the secondary frequency and voltage are both small, the secondary frequency, to generate such voltage must also be correspondingly increased. This secondary frequency, which represents the departure from synchronous speed, or the "slip," is therefore always proportional to the secondary voltage. Speed

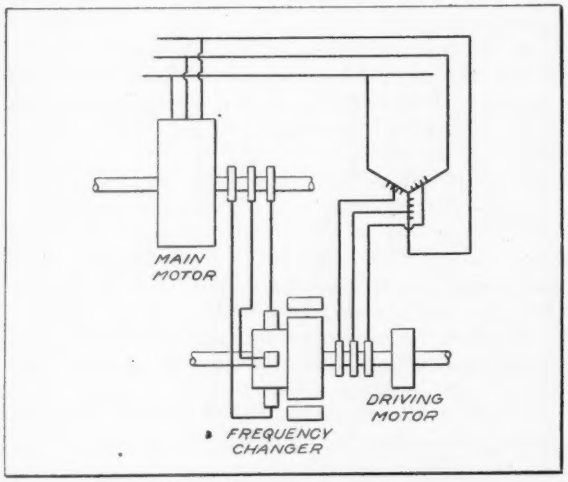


FIG. 1. DIAGRAM OF CONNECTIONS SHOWING FREQUENCY CHANGER TRANSFORMING SECONDARY FREQUENCY OF INDUCTION MOTOR TO PRIMARY SERVICE FREQUENCY

regulation of the motor, by means of the secondary circuit, means, therefore, corresponding, or proportional variation in the secondary frequency and voltage, and all methods of speed regulation or adjustment of induction motors through secondary control are based upon frequency and voltage variation in the secondary circuits.

All methods of speed regulation of induction motors may be classified under 2 general heads; (1) primary circuit control, and (2) secondary circuit control.

*From a paper read before the Association of Iron and Steel Electrical Engineers.

PRIMARY CIRCUIT CONTROL

TWO GENERAL methods are practicable, namely, variation in the number of primary poles, and variation in the frequency supplied to the primary. The former method is limited in the range of control which is practicable. Usually, 2 operating speeds can readily be obtained, while 3 or 4 lead to much added complication, and more than 4 speeds do not appear to be commercially practicable except in special cases. For fine graduations in speed, pole changing is apparently out of the question.

By suitable change in the primary frequency supplied to the motor, any desired speed, or speed range, is obtainable. But the problem of furnishing this variable frequency is just as serious as that of speed adjustment of the motor itself on a fixed frequency. In other words, it takes the difficulty away from the motor and transfers it elsewhere, but does not eliminate it.

There are various ways of generating variable frequency. For instance, an alternator may be driven by an adjustable speed motor. This should be a direct-current motor, for, if an alternating motor is used, the problem of varying its speed is just the same as that of the induction motor which is to be regulated. Another way is to connect the alternating-current generator to an adjustable speed prime mover, such as an engine or water-wheel. Such methods of regulation require one generating outfit for each motor to be regulated, except where 2 or more motors are to be regulated over the same range at the same time. The method in general is seldom used.

Other possible methods of regulating the primary frequency lie in frequency changers of certain types by which a given frequency can be converted to any other frequency by commutation of alternating current. Various types of such machines are possible, but they possess certain objectionable limitations, in that they must commutate currents of frequencies approximating those of the primary supply system. At 25 cycles, this may be practicable, in some cases, but on 60-cycle supply circuits it is out of the question. One other serious objection to regulating the primary frequency is that the frequency controlling device must have a capacity equal to that of the motor to be regulated,—that is, the entire input of the induction motor must be handled by the frequency regulator.

In general, therefore, regulation of induction motor speed by change in primary frequency is not advisable, and appears to be practicable only in certain special applications.

Speed Control by Change in Secondary Frequency

As brought out before, any speed variation of an induction motor with unchanged primary frequency means accompanying change in the secondary frequency and voltage. At standstill, the secondary voltage is a maximum, and the secondary frequency is 100 per cent of that of the primary,—that is, it is the same as the primary. At true synchronous speed, the secondary voltage and frequency are zero. At any intermediate speed, the secondary voltage generated and the secondary frequency are respectively equal to the standstill voltage, and the standstill or primary frequency, multiplied by the slip, in per cent, the slip being the drop from synchronous speed. It should be noted that the secondary generated voltage is mentioned, for this is not the same as the secondary terminal voltage, due to a certain internal drop in the windings when current is flowing. This internal drop is usually small compared with the secondary standstill voltage, usually being from 2 to 3 per cent, except in small motors, and therefore may be neglected in any general discussion not involving exact calculations.

All methods of secondary circuit control in induction motors include some method of regulating or controlling the secondary voltage and frequency. The simplest practical device is the use of resistance inserted in the secondary circuit. In order to get the required current, for a given torque, through such resistance, the voltage must be increased and this requires increase in the secondary frequency,—that is, drop in speed. But, with a given resistance, if the load or torque is varied, the secondary current must vary, which means corresponding variation in voltage and secondary frequency,—that is, in speed. Therefore, speed regulations by secondary resistance means variable speed with variations in torque; and constant speed with variation in torque is obtainable only by varying the resistance inversely with the current, in order to obtain a constant voltage drop. Such method of speed regulation is therefore satisfactory only to a limited extent; moreover, it is uneconomical, in that there is a rheostatic loss practically proportional to the drop in speed below synchronism. At half speed, for instance, half the output of the motor is wasted in resistance.

Obviously, what is needed is some arrangement which will absorb the required secondary voltage in other than resistance, and which will automatically hold such voltage constant, with varying current, in those cases where constant speed characteristics are required for each speed setting. The difficulty in obtaining such a device is not simply in the voltage range required, but is largely on account of the range in frequency necessary. All such devices must, therefore, be of adjustable frequency, and therein lies the true difficulty, just as in the case of frequency changers in the primary circuit, as already referred to. The difficulty, however, is not nearly so serious in the case of regulation of the secondary circuit, for the variable frequency device needs to be of a total capacity corresponding to the slip, in per cent. Furthermore, where the departure from synchronism is not large, the actual frequency in the frequency controlling machine is so low that commutator type alternating-current machines are permissible up to relatively high capacity. The problem therefore resolves itself into one of variable frequency, just as in the case of primary circuit regulation, as already referred to, except that the frequencies and capacities dealt with usually are much lower in the case of secondary circuit control. The problem is simply easier, but not of a different nature.

In all methods of rating by secondary control, the regulating device must absorb power corresponding in per cent practically to the secondary terminal voltage, or the secondary frequency, or slip. This power must be utilized if economical operation is required. There are 3 general methods by which it can be utilized, namely, it may be transformed to mechanical power and assist in driving the motor shaft, or it may be transformed to the primary or line frequency and fed back into the line, or it may be transformed to direct current for use in some other part of the system. Combinations of these 3 methods may be used. For instance, this secondary power may be transformed to direct current and then be transformed to mechanical power by means of a direct-current motor connected to the induction motor load. Or, it may be transformed to direct current and then re-transformed to the primary frequency and fed back into the line.

Three types of variable frequency devices have been proposed for absorbing the secondary terminal voltage, namely, alternating-current commutator motors, rotary converters, and commutator type frequency changers. In the first named, the alternating-current commutator motor either delivers its power directly to the shaft of the induction motor, or to an alternating-current generator which returns it to the line, or to a direct-current generator which delivers its current to some direct-current system or load where it can be utilized. In the second type mentioned, a rotary converter absorbs at its collector rings the secondary terminal voltage and transforms it to a proportional direct-current voltage. The direct-current power is then fed into a direct-current motor connected with the induction motor load, or is transformed to the primary frequency by a suitable motor-generator set. In the third type, a commutator type frequency changer transforms the secondary terminal voltage and frequency to proportionate voltage at the primary frequency, and, by means of suitable transformers, the secondary power is then returned to the primary supply circuit.

Each of these arrangements possesses some advantages over the others, and also some disadvantages. The alternating-current commutator motor is a relatively expensive type of machine, especially for exceptionally low speeds. Therefore, when the induction motor to be regulated is of comparatively low speed, placing the commutator motor on the induction motor shaft means a relatively expensive commutator machine. In such cases, it may be advisable either to gear it to the load or to connect it to a generator which returns power to the line or delivers it to another system. By such means, a smaller and higher speed commutator type alternating-

current motor may be used, but at a certain expense in auxiliary apparatus. For a frequency of 25 cycles, the alternating-current commutator motor does not present any undue inherent difficulties if the speed range of the secondary control is not too large. With 50 per cent drop in speed, for instance, the frequency handled by the alternating-current commutator motor is only 12½ cycles. But with a 60-cycle supply system, a speed range of 50 per cent means that the alternating-current commutator motor must handle 30 cycles, which is a much more difficult and expensive proposition.

With the rotary converter speed regulation, no new or difficult problems are involved, either in the transformation or utilization of the secondary power. Where the induction motor speed is not too low, a direct-current motor connected to the shaft may utilize the direct-current power from the rotary converter. However, unlike the alternating-current commutator scheme above

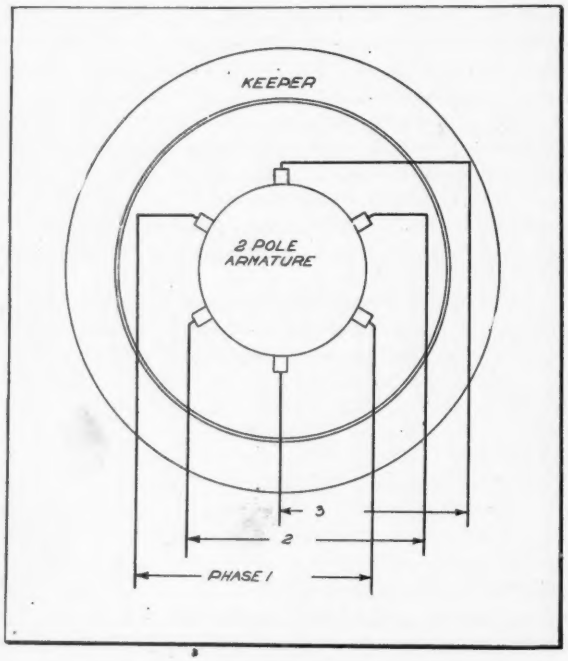


FIG. 2. SIMPLE FORM OF FREQUENCY CHANGER CONSISTING OF IRON RING WITHOUT WINDINGS SURROUNDING ARMATURE

described, the rotary converter arrangement makes its best showing in connection with 60-cycle supply systems, for, with the higher frequency, the secondary frequency of the main motor is correspondingly higher for the same speed range, which allows the use of a relatively smaller rotary for the same percentage of power transformed. To illustrate: On a 25-cycle supply system, with 30 per cent speed range, the maximum secondary frequency is 7½ cycles. A 4-pole rotary operating at this frequency will run at 225 r.p.m.; that is, at this speed, it transforms or utilizes 30 per cent of the power of the induction motor. Considering now, 60 cycles, with the same speed range, the secondary frequency becomes 18 cycles, and a 4-pole rotary of 30 per cent of the motor capacity will operate at 540 r.p.m. on this frequency. Obviously, a rotary converter of much smaller dimensions can be used, than in the former case. The auxiliary means for absorbing the direct-current power from the rotary converter can be practically the same for either frequency. Therefore, with this method, 60 cycles makes the better showing.

In the third scheme, Fig. 1, the secondary frequency of the induction motor is transformed directly to the primary frequency in a single machine. The auxiliary means for utilizing the transformed power consists of suitable stationary transformers with taps for varying the voltage. As the frequency changer is a rather unusual device, a brief description of its principle may not be out of place at this point.

Frequency Changer

As usually built, this consists of an armature like that of a rotary converter, equipped with both commutator and collector rings. Unlike the rotary, the field may consist of a simple "keeper" or ring, as shown in Fig. 2, without windings, which encircles the armature. Also, unlike the rotary converter, the commutator is equipped with a double or triple set of brush holders for handling polyphase current. The ordinary spacing of the direct-current brush holders on a direct-current rotary would correspond to one phase of the frequency changer. The armature can be driven by any suitable small capacity, adjustable speed device. Practically the only load carried by the driving device consists of brush friction and windage.

If such a machine has its collector rings connected to the main supply system through suitable transformers, a rotating field will be set up in the armature core (and keeper) which travels around the core at a speed corresponding to the frequency divided by the number of poles, just as in an induction motor. If, now, the core is rotated mechanically in the opposite direction, at a speed equal to the frequency divided by the number of poles, then the magnetic field set up in the core will stand still in space and could be replaced by an external field excited by direct current, just as in a rotary converter. Under this condition, the brushes on the commutator would tend to deliver direct current,—that is, alternating current having zero frequency. Under this condition, the external stationary keeper has zero frequency in it, while the armature core has normal frequency. Assume now that the core is rotated either faster or slower than synchronous speed. The magnetic field set up by the armature winding will travel backward or forward in space at a speed corresponding to the departure of the core from synchronism and the brushes on the commutator will tend to deliver alternating current at a frequency proportional to the departure of the armature core from synchronous speed. Thus, by varying the speed of the armature core from synchronism, any desired frequency can be obtained at the commutator brushes. But the voltage at the commutator brushes is practically equal to the voltage at the collector rings, regardless of the speed of rotation, and by varying the voltage supplied to the collector rings, the voltage at the commutator can be varied independently of the frequency, which is dependent solely upon the speed of the armature. Thus, independent control of the voltage and frequency is obtainable, which makes

the device quite flexible in its application. But such a device has other desirable characteristics. As it is primarily one form of rotary converter, we should naturally expect that it would show some of the small-copper-loss characteristics of the rotary converter. Analysis, however, shows that it goes even further than this. In a 6-phase rotary converter, for instance, the armature copper loss averages about 26 per cent of that of a corresponding direct-current winding, due to part of the alternating current being fed directly through to the direct-current circuit without transformation; but, as there is transformation from one kind of current to another, the operation is incomplete, and there are certain transformation losses which are especially large at and near the so-called tap coils, which are connected to the collector rings. But in a 6-phase frequency changer of the above type, the transformation is from 6-phase alternating current to 6-phase current of another frequency, and a still larger per cent of the current passes through without transformation than is the case in a 6-phase rotary converter. In consequence, the frequency changer has only about ⅔ as much copper loss as a rotary converter; that is, for 6-phase, it is less than 18 per cent of that of a corresponding direct-current machine. Moreover, the high tap-coil losses of the rotary converter are practically absent. It thus becomes an extremely effective transforming device, as far as frequency is concerned.

Such a device is also very economical as regards iron losses. As it generates voltages, when connected to the secondary terminals of an induction motor, which are proportional to the speed range, obviously, with moderate speed variations, the magnetic flux in the armature core will be small compared with what would be necessary to generate full secondary voltage. Also, even this reduced induction is at a comparatively low frequency in the surrounding ring or keeper, and is at full frequency only in the armature core proper. Evidently, therefore, the armature core and armature teeth sections can be made relatively small where the range of speed adjustment is small, such as 25 to 35 per cent from synchronism. This small average core loss, together with the very small copper loss tends toward an economical construction of machine.

In such a frequency changer, the problems of commutation are similar to those in the alternating-current commutator motor, and at 25 cycles the design becomes simpler and easier than at 60 cycles. The machine is independent of the speed of the induction motor to be controlled, which is not the case with the alternating-current commutator motor in its simplest application, namely, direct connection to the main motor shaft. Such a frequency changer in its simplest form may be arranged to be self-compensating, and the commutating conditions can be brought well within those of well-proportioned alternating-current commutator motors.

INSULATING MATERIALS rapidly deteriorate and iron soon ages if exposed for long periods to 170 deg. or higher temperatures, hence it is usual to specify this as the maximum working temperature of transformers and 120 or better 100 deg. as the maximum, permissible temperature rise above atmosphere.

"Motoring" of Generators

CAUSES OF REVERSALS IN SHUNT AND COMPOUND WOUND GENERATORS, AND THE REMEDY

ALL direct-current and most types of alternating-current dynamos are reversible and may readily be used as either generator or motor, as desired. It will, therefore, be understood how, under certain conditions, a generator operating in parallel with other machines may reverse and become a motor, or as it is termed will "motorize."

With 2 shunt-wound generators having identical external characteristics and driven by like prime movers, the load being carried may be divided between the 2 machines as desired by means of their field rheostats, and due to their like characteristics and driving units, will maintain this division of load throughout their range of capacity. If, however, there be any difference in the performance of the prime movers, or in the external characteristics of the machines at any point of the load, or if the division of load be changed by a readjustment of the field rheostats, the above-mentioned ideal conditions of operation will not prevail, and, as a result, one machine, due to its greater generated electromotive force, will take more than its share of load. The other machine, due to its lesser generated electromotive force, will then be caused to take less than its share of the load, and if its electromotive force be still further reduced, its armature current will be reversed, so that it will be driven by the other generator, thereby acting as a "motor."

Since, under the above-mentioned conditions, it is seen that 2 shunt-wound generators may be satisfactorily operated in parallel, it may be seen at first, that the addition of series windings should not, in any way, affect the operation of compound-wound machines, and that all that has been said relative to shunt-wound machines may be applicable to compound-wound generators.

Experience shows, however, that unless an equalizing connection is made between them, 2 or more compound-wound machines will not run stable in parallel. The cause of this is as follows: Suppose that, for some reason, machine No. 2 gives a slightly higher induced electromotive force. As a result, this machine would take a slightly larger share of the load than No. 1, hence a larger current would flow through the compound winding of No. 2 than through that of No. 1. The electromotive force of No. 2 will thereby be still further increased and the load of the other machine decreased. This will continue until No. 2 carries the entire load, while No. 1 runs at no load. Then, unless the machines are provided with some form of reverse-current circuit breakers, generator No. 2 will reverse the current in No. 1 and will drive it as a motor. Such action would do no harm to a shunt machine, but with a compound-wound machine, the reversed current flowing through the series field coils of No. 1 weakens the total field and the machine begins to run faster and faster, dragging its prime mover. This causes machine No. 2 to become overloaded, and it slows down. Then machine No. 1, due to its higher electromotive force caused by the increased speed, causes a sudden rush of current into the

line and into the other machine; the phenomenon then repeats itself with the machines exchanging their relation of driver and driven.

Demotorizing Dynamos

Shunt-wound generators which have, as above outlined, "motored," may readily be restored to their proper function by decreasing the resistance of the shunt field by means of the rheostat. While it is possible, especially at some points of the load, that, due to a wide difference in external characteristics, no amount of rheostat adjustment will remedy matters, it is not probable that such trouble would arise with any modern machine. It may, therefore, safely be said that should the generator motorize, an adjustment of the rheostat whereby the field resistance is decreased, will result in a reversal of the armature current, with a consequent picking up of the load.

On the other hand, on account of the peculiar action explained above, no amount of adjustment of the shunt field resistance of a compound-wound generator will result in its satisfactory operation, unless the various machines are inter-connected by an equalizer, the function of which is to prevent the currents in the series fields of the 2 or more machines from differing widely from each other, or from reversing, however different their armature currents may be. When connected by an equalizer, therefore, different machines cannot have widely different voltages, cannot easily have the load disproportionately distributed, and the possibility of one machine pumping power back into the other becomes more remote.

While 2 or more identical compound-wound machines, provided with an equalizer, will distribute current among themselves equally well at all loads, a difficulty arises when the machines have different characteristics. The equalizer connection cannot remedy this fault, and the only thing to do to eliminate continual trouble due to this difference in characteristics would be to rewind the machines so that the performances of all would be practically identical.

Using the Slide Rule

Application of the Logarithmic and Trigonometric Scales

NOT the least important feature of the modern slide rule is the provision of the special scales by the use of which, in conjunction with the ordinary scales on the rule, a large variety of trigonometric computations may be readily performed.

On the reverse or under side of the slide of the ordinary Mannheim rule will be found 3 scales. One of these is an evenly divided scale by which the decimal parts or mantissas of logarithms of numbers may be obtained. Usually this scale is the center one of the 3, but in some rules it will be found occupying the lowest position. The upper of the 3 scales distinguished by the letter S is a scale giving the logarithms of the sines of angles and is used to determine the natural sines of angles of from 35 min. to 90 deg. The notation of this scale is evident on inspection. The main divisions 1, 2, 3, etc., represent the degrees of angles; but the values of the subdivisions differ according to their position on the scale. Thus, if any primary space is subdivided into 12 parts, each of the latter will be read as 5 min., since 1 deg. equals 60 min.

The third, the tangent scale, found on the back of the slide, is usually designated by being lettered T. In most of the more recent forms of rules, this scale is placed near the lower edge of the slide, but in some it is found to be the center scale of the 3. In some rules, this scale is graduated in the same direction as the scale of sines—viz., from left to right—while in others it is reversed.

Instead of using the Mannheim rule in this discussion, we will, for simplicity's sake, use the Richardson Direct Reading Slide Rule, which, as shown in Fig. 1, has all the scales on the face of the rule and slide. On this rule, the sine scale is at the top, the tangent scale directly below the D scale, while below the tangent scale is the logarithmic scale.

Use of Trigonometric and Logarithmic Scales

By the use of the slide rule, the logarithm of any number may be more easily and quickly found than by resorting to a logarithmic table.

To find the logarithm of any number, place the hair line of the runner over that number on scale D and find the logarithm directly below on the logarithmic scale. For example, let it be required to find the log of 25. Place the runner over 25 on the scale D and on the logarithmic scale below find 397, to which should be added the characteristic 1, as explained in Using Logarithms, on page 172 of the February 1, 1915, issue. The logarithm of 25 is, therefore, as read from the rule, 1.397. In a like manner, the logarithm of any other number is found.

Evolution and Involution

To raise a number to any power, place the runner to the number on the D scale, read its log on the log scale, being careful to give it the correct characteristic. Transfer the entire log, index and all, to the D scale; multiply this log by the power wanted and the result is the log of the number required. To find the number, place the runner to the mantissa on the log scale and above it on the D scale read the number wanted.

As an example, let us find the 6th power of 9.

Place the runner to 9 on the D scale, and under it on the log scale read mantissa of 9, which is 0.955, giving it its proper characteristic, which in this case is 0. Set 1 on the C scale to 955 on the D scale and under 6 on the C scale, read on the D scale, 5.725, the log of 9 to the 6th power. Then place the runner to 725 on the log scale and above it read 531 in round numbers. Having a characteristic of 5, the number of places to the left of the decimal point is 6, making the 6th power of 9 equal to approximately 531,000.

To extract the square root of any number, the process is similar, but the log of the number is divided by the index of the root to be extracted, and the quotient is the log of the required root.

Let us extract the 4th root of 50,625.

Place the runner to 506 on the D scale and under it read the mantissa of its log on the log scale, this being 7043; giving this its proper characteristic, 4, we have 4.7043. Place 4 on the C scale over 4704 on the D scale and under 1 on the C scale read 1177 on the D scale; by inspection of the value this is 1.177, which is the log of the root required. Then place the runner to 177 on the log scale and over it on the D scale read 15, which has 2 figures, in the integer, since the characteristic of its log was 1. The value of any number raised to the power indicated by a fractional exponent may be found by the use of the logarithmic scale. Let it be required to find the value of 4 to the power of 5/2, which in reality is the square root of 4 raised to the 5th power. From the log scale we find that the logarithm of 4 is 0.602, whence log 4 to the power of 5/2 is equal to 0.602 times 5/2 or 1.505. To carry out this multiplication, place 2 on the C scale over 602 on the D scale; bring runner to left-hand index of C scale; right-hand index of C scale to runner; runner to 5 on C scale, under which, on D scale, find 1.505. By placing the runner over 505 on the log scale we find directly above on the D scale, 32, which is, therefore, equal to 4, to the power of 5/2, the index of the logarithm being 1.

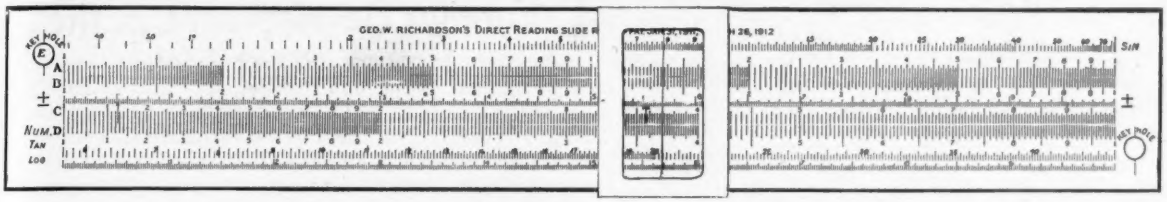


FIG. 1. BY PLACING RUNNER OVER 370 ON THE D SCALE WE FIND THE MANTISSA OF ITS LOG, 568, ON THE LOG SCALE BELOW

To find the value of sine 45 deg., we place the runner over 45 deg. on the sine scale and find on the A scale 707; as this is on the right-hand side of the scale, the value is in tenths and is written 0.707.

As stated above, the cosine of any angle is equal to the sine of (90 deg., minus that angle), or in other words, if we desire to know the cosine of 42 deg., we find the sine of (90 minus 42 deg.), or 48 deg., which from the right-hand A scale is found to be 0.743.

The cosine of 87 deg. is equal to the sine of (90 minus 87 deg.), or 3 deg. The sine of 3 deg. is 0.0523.

Log Sine and Log Cosine

To find the log sine or log cosine, place the runner to the required angle on the sine scale and read the value of the natural function; transfer this to the D scale and below it in the log scale read the mantissa of the log required, placing the index by the following: As all natural sines or cosines are less than 1, the logs of these will therefore have a negative index. If the natural function of the angle is found in the left-hand A scale the index will be —2 or 10—2, and will be written 8; if, however, found on the right-hand A scale, the index will be —1, or 10—1, and will be written 9.

This may be illustrated by finding the log sine of 27 deg. 30 min. Placing the runner over 27 deg. 30 min., we find its sine on the A scale to be 0.462. Then,

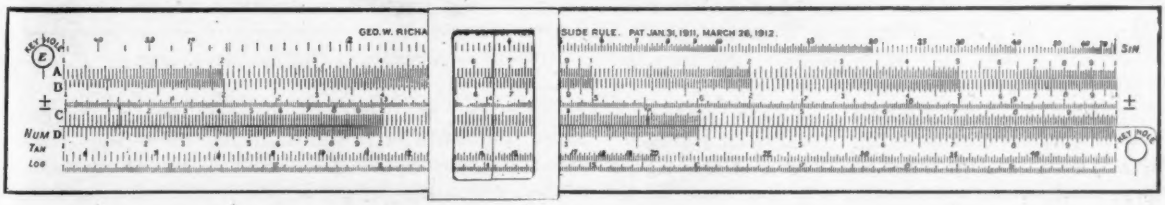


FIG. 2. THE SINE OF 3 DEG. 45 MIN. IS FOUND ON THE A SCALE DIRECTLY BELOW TO BE 0.0654

Trigonometric Functions

Above the A scale and marked sine is the scale of natural sines ranging from a trifle less than 35 min. to 90 deg., so that by placing the runner over any degree of angle the sine of that angle is found directly below on the A scale. The log sine can be found by transferring the value of the natural function as found on the A scale to the D scale and then reading below this on the log scale the log corresponding to this natural function, or in other words, the log sine.

From trigonometry, we know that the cosine of any angle is equal to sine of its complementary angle, or 90 deg. minus that angle. Either the cosine or its log for any angle may, therefore, be easily obtained by the use of the sine scale, and this relation of cosine to sine of the complementary angle.

The value of the sine or cosine found on the left of the center of scale A must have a 0 between the decimal point and the first figure, while for those values found on the right hand of the middle index, the first figure follows the decimal point directly.

Let us find the sine of 3 deg. 45 min. Place the runner so that the hair line is directly over 3 deg. 45 min. Below on the A scale find 654. Due, however, as stated above, to the fact that this figure lies on the left hand side of the scale the actual value is 0.0654.

setting the runner over 462 on the D scale, we find below on the logarithmic scale the value of 664. As the sine was found on the right-hand A scale, the index will be —1, and the entire log will read 9.664.

Again, to find the value of log cosine 40 deg., we find the sine (90 minus 40) or sine 50 deg., which, on the right-hand side of the A scale, is 0.766. Transferring this to the D scale we find under it on the log scale 884, which, on account of the natural function having been located on the right-hand end of the A scale, is 9.884.

Tangents

Directly below the D scale is the scale of tangents, marked Tan, and graduated for angles from a little less than 6 deg. to 45 deg., corresponding to values of tangent on the D scale from 0.1 to 1.0.

If the tangent of an angle less than 6 deg. is desired, the sine scale may be used up to 6 deg., as there is but negligible difference between the sine and tangent so far as slide rule work is concerned.

As an example of the use of the tangent scale, let us find the tangent of 40 deg. 15 min. Place the runner over 40 deg. 15 min., and above on the D scale we have 0.846.

What is the natural tangent of 4 deg. 30 min.?

Place the runner on 4 deg. 30 min. on the sine scale and below it on the A scale find 785, to which, on account of being found on the left-hand A scale, prefix a zero so as to be 0.0785.

To obtain the tangent of an angle greater than 45 deg., it becomes necessary to resort to the use of trigonometrical relations. That is, for angles greater than 45 deg., the tangent is equal to 1 divided by the tangent of the complementary angle, or (90 deg. minus the angle in question). Or, the tangent of any angle is equal to the quotient obtained by dividing the sine of that angle by its cosine.

This may be illustrated as follows: Required, the tangent of 60 deg.

By the first method, we divide 1 by the tangent of 90 minus 60, or 30. The tangent of 30 deg. we find from the D scale to be 0.577. Place 1 on C over 577 on D, and over 1 on D find 1.732 on C, which is, therefore, the tangent of 60 deg.

Now using the second method, we have the sine of 60 is 0.866 and the cosine 60 deg. (equal to sine 30 deg.) is 0.500. Place 5 on B under 866 on A and above 1 on B find 1.732 on A, which, as in the first case, is the tangent of 60 deg.

Log Tangents

As the logarithmic scale corresponds to line values on the D scale, and as the D scale is used in connection with the tangent scale, it is apparent that for values of tangents of angles within the scope of the D scale, that is, from 6 to 45 deg., the log tangents can be read directly under the value of the natural tangent.

By placing the runner to the angle on the tangent scale the mantissa of the log tangent can be read directly under it on the log scale. Should the angle, however, be less than 6 deg., the sine scale may be used instead, and if greater than 45 deg., one or the other of the 2 formulas given above may be employed.

After finding the mantissa of the log, its proper index may be given by the following table:

Angles			Index
1 deg.	to	5 deg. 42 min.	10—2 or 8
5 deg. 43 min.	to	45 deg.	10—1 or 9
45 deg.	to	84 deg. 17 min.	0
84 deg. 17 min.	to	89 deg. 25 min.	1

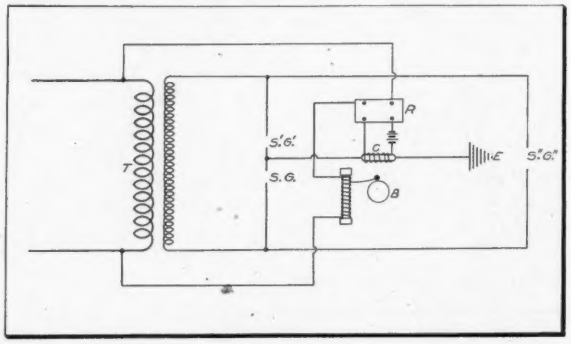
Let us find the log tangent of 33 deg.

Place the hair line of the runner over 33 on the tangent scale, and below on the logarithmic scale find 813. This, according to the above table, should have an index of 9, making the log tangent of 33 deg. equal to 9.813.

Foreign Development in the Power Plant Field

Effect of Frost on the Setting of Cement; Methods for Protection Against Rust; Friction in Coated Hydraulic Pipes; Strong Smoke Indicator. By J. H. Blakey

At a recent meeting of the Institute of Civil Engineers of London, J. Hammersley Henau read a paper recording some experiments made by him on the influence of frost on the setting of concrete. These observations show that frost has no great effect upon the resistance of concrete if it does not occur before



THE STRONG SMOKE INDICATOR

2 days after the commencement of setting; the only effect appears to be a retardation of the setting. It is rather the succession of freezing and thawing before setting which has injurious effects. To place concrete in winter it is therefore sufficient to maintain the ingredients at a sufficiently high temperature during mixing, and to keep the structure at a few degrees above freezing point for 2 days.

Protection of Iron and Steel Against Rust

The Bulletin de la Societe d'Encouragement gives some of the methods in use for the protection of iron and steel against rust. These are chemical or electrochemical processes for the production of a coating of black oxide of iron, phosphate of iron, or other compound which is not attacked by moisture.

The Bradley process consists in heating the iron or steel to a dull red in a muffle furnace in presence of hydrogen gas and a small quantity of gasoline, which

is allowed to pass off at the end of the heating, which lasts about one hour. After cooling, the pieces are oiled with linseed or paraffin oil. This method, applicable to castings and to steel, gives a regular coating, black, and impermeable to water. The Bontempi process consists in heating in a muffle furnace to a temperature of 864 deg. F., and then passing the iron or steel into the vapor of zinc or tar. This gives a thick black coat.

A cold process, especially suitable for cutting tools, and which is used for treating gun barrels, consists in covering with a solution of ferric chloride, 1 part; water, 8 parts; alcohol, 8 parts. The articles are then placed in a chamber heated by and filled with steam, and are finally plunged into boiling water. This treatment is repeated 2 or 3 times, after which the pieces are brushed and greased.

A coating of black oxide of iron can also be produced by dipping in melted saltpeter, or, in the case of small articles, by heating in charcoal. The Cosslett process gives a good coating, very resistant to rust, and is simple and economical. It consists in the immersion for about 3 hr. in a warm solution of phosphate of zinc. After drying, the articles are brushed with a wire brush and greased.

Effect of a Smooth Coating in Hydraulic Pipes in Diminishing Friction

Experiments made at the Ecole Superieure de Stuttgart, on the flow of water in concrete pipes, show that when they are given a smooth coating, the internal resistance is greatly diminished. Pipes of about 6 in. internal diameter were used. It was observed that the diminution of resistance was proportionally greater, in favor of the coated pipe, as the velocity of the water increased. When the water had a velocity varying from 26 to 67 in. per sec., the decrease of resistance in the coated pipe in relation to that of the uncoated pipe increased from 2.5 to 7.1 per cent.

The Strong Smoke Indicator

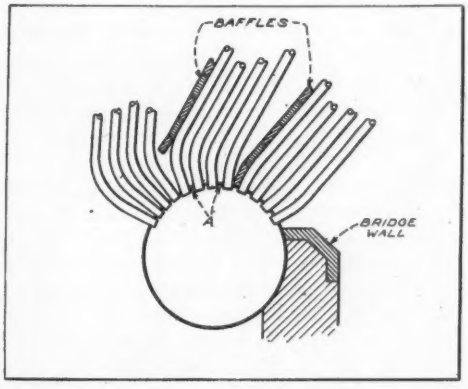
The action of the Strong smoke indicator depends upon the fact that under normal conditions the gases leaving a furnace are strongly ionized. When smoke is present, the ions combine with the particles of carbon and set up an electrical resistance. Advantage has been taken of this to devise the indicator the operation of which is illustrated by the accompanying diagram. The apparatus consists of a small step-up transformer, T, of from 75 to 150 w. capacity, operating on 110-v., alternating-current, 60-cycle circuits, stepping up to about 26,000 v. The high tension side is connected to 2 sets of spark gaps placed in parallel, S″G″ being in the smokestack and S′G′ and SG in the boiler room. When there is no smoke in the chimney, the electrical discharge takes place at S″G″ in the chimney. When the smoke reaches a certain amount, depending upon the setting of S″G″, S′G′ and SG, the discharge is driven to SG and S′G′, and is oscillatory. The remainder of the apparatus is practically that used in wireless telegraphy a few years ago. The discharge takes places to an electrode grounded at E through the coherer. The coherer operates the relay R through a small dry battery. The relay may be made to operate an alternating current bell, B, and any other devices which may be controlled by an electric circuit. These may include a time-recording mechanism by means of which a daily smoke chart can be produced, or a lamp circuit through which a lamp may be illuminated whenever the smoke reaches a certain density.

Beaded Tubes in Stirling Boilers

To Give Drainage and Avoid Air Pockets. By Thomas Grimes

It is now the practice of the builders of the Stirling water-tube boiler to bead all those tubes entering the lower sections of the steam and water drums and those entering the upper section of the mud drum. Those in the upper drums are beaded to afford better drainage when the boiler is blown down, while those in the lower drum are beaded to avoid the presence of an air lock in the top of the mud drum.

When those tubes entering the mud drum are not beaded, an air lock will exist, but when such is the case no injury can result. Each time the boiler is refilled, a small quantity of air is trapped at point A, in the accompanying figure, due to the tubes protruding into the drum and as the water rises, this air is caught between the upper surface of the water and the shell.



TUBES ENTERING MUD DRUM OF STIRLING BOILER; AIR LOCKS LOCATED AT POINT A

The volume of this entrapped air may be easily calculated. Multiply the area of the small segment by the length of the drum and from the product subtract the product of the cross-sectional area of one tube times the distance it projects into the drum times the number of projecting tubes included in the segment. The maximum distances that unbeaded and beaded tubes will project is about ½ and 3/16 in. respectively.

Suppose the boiler is filled, the fires started and an opening from the interior to the atmosphere through a gage cock or other means made. As the temperature of the water increases the air held in solution is liberated to the steam space and finally driven out of the boiler. As this air is driven off, the water will absorb that contained in the air lock, thus freeing itself.

Another condition under which an air lock will be created is when applying a hydrostatic test. The pressure carried is as a rule 50 per cent in excess of the working pressure and, in event of a leaky tube at the

highest point in the mud drum the air will escape and moisture show where the tube enters the drum long before the highest pressure is reached.

The air lock is more of a fancy than a fact, but there are several good reasons why not a few but every tube end in all the drums should be beaded. It presents a smoother surface on which scale cannot so readily collect, in using a rotary tube cleaner the machine will not break off the end as is frequently the case if the tubes are only flared, and it necessitates the use of tubes of sufficiently good quality to stand beading. The quality of the tubes is a matter that seems to have been overlooked in boiler rules now in use and also in the proposed code of the A. S. M. E. in spite of the fact that tube failures form by far the greatest proportion of the accidents to water-tube boilers.

Insulation

HARMFUL INSULATION; PIPE COVERING. BY A. G. SOLOMON

IN OPERATING an ice or brine tank or brine cooler of any kind or direct expansion coils, the heat is taken up by the vapor or fluid circulated through the pipe coils. Anything which interferes with the passage of the heat can be regarded as harmful insulation and should be removed. Frost accumulating on coils is detrimental to good results. If the frost cannot be melted off, it should be scraped off whenever it retards proper refrigeration. A clean, direct expansion coil will do twice as much effective work as one with an inch of hard frost on it.

One of the points in favor of the open brine system is the entire absence of any material between the brine and the air from which the heat is to be drawn. Coils through which brine is circulated can be quickly cleaned of frost by pumping warm brine through them for a short time. The loss resulting from the heating of the brine will be more than regained by the good results obtained by the use of clean coils.

In the use of direct expansion coils, the ammonia has no chance to evaporate quickly if insulated from the warm air by a heavy coat of frost.

The insulating effect of ice on ammonia coils is most readily seen in ice or brine tanks or shell type coolers. When the brine is too weak to withstand the extreme cold temperature of the vapor in the coils, a coating of ice is formed on the pipe. The back pressure corresponding to the temperature of the brine cannot be carried, as the heat in the brine cannot be taken up readily by the vapor owing to the ice. This reduced back pressure results in a displacement of a less weight of ammonia by the compressor resulting in greater speed to do the required work and therefore increasing the power cost. Keep the submerged coils free of ice by testing the density of the brine frequently and, whenever necessary, adding salt, which is cheaper than coal.

Next comes the insulating effect of scale on ammonia and steam condensers and flat cooler coils. Ammonia condenser pipe will generally begin to show the impurities in the water by the accumulation of a green slime. This slime turns into a thin, hard scale if allowed to remain. Have a hose connection at the condensers, wash the slime off and do not give the scale a chance to form. In double-pipe condensers, flush out the inner tubes at regular intervals.

Steam condensers are generally kept reasonably free of scale, as this part of the ice plant will surely let the operator know when it needs cleaning. The distilled water will not be supplied in sufficient quantity and the air or gas reliefs will blow, calling attention to the insulating effect of the scale.

The scale on the flat cooler coils will be noticeable by the increased temperature of the distilled water going to the fore cooler or into the ice cans. Make the cooling water do as much work as possible by allowing it to come in as close contact as possible with the fluid to be cooled.

Inner surfaces of ammonia and distilled water pipe and coils have to be kept free of oil, which is also a good insulator.

BOILERS, STEAM PIPE AND STEAM CYLINDERS

INSULATION of the radiating surfaces of boilers, steam pipe and other vessels containing steam, is a subject that has been gone into thoroughly by experts and manufacturers of insulating material. Loss by radiation and condensation has been made so self evident that uncovered steam pipe is an uncommon sight in a plant of any importance.

Boilers, after being properly bricked in, have really no exposed surfaces unless they have been neglected and leaks allowed to develop in the furnace walls. Such leaks are easily found and just as easily repaired with asbestos cement. In one way, this is not really leakage through insulation; but it amounts to the same thing, since air drawn through the walls strikes the uninsulated parts of the boiler.

Sometimes the furnace lining is so badly burned away that a great amount of heat is lost by its radiation through the outer brick work. At times, this radiation is so bad that the hand cannot be held against the outer wall on account of the heat. Tight flue doors are necessary for the same reason as tight brick work. The tops of boilers need a coating of insulating material, as that is the one part of the shell that does not come in contact with the heat from the furnace; 2 layers of brick laid in mortar, the usual covering, is sufficient if kept in repair. The steam dome should be insulated with a covering of asbestos, mineral wool or magnesia, for none but fireproof material can be used with any degree of safety in the covering of steam vessels.

The blowoff line must be well insulated where it passes through the combustion chamber to prevent its being burned in case of an accumulation of scale. Asbestos rope one inch in diameter is good, cheap and durable for wrapping the blowoff line.

Steam pipe, receivers and separators are all covered with fireproof material. Such covering comes in sections or molds to fit any size pipe or fittings and is put on just as it comes from the factory and fastened with metal bands which are also furnished. Steam cylinders of engines and pumps are usually covered with a cement

made of asbestos or mineral wool and applied with a trowel before the lagging is put on.

Loss from an uncovered steam pipe with a pressure of 150 lb. is rated at about 12 B.t.u. per min. per sq. ft. of surface exposed to an atmospheric temperature of 80 deg. This loss is reduced to between 2 and 3 B.t.u. by the use of proper insulating material. The loss by radiation and condensation is much greater when uncovered pipe is exposed to a draft or constantly moving air than when the air is comparatively still, as in a building.

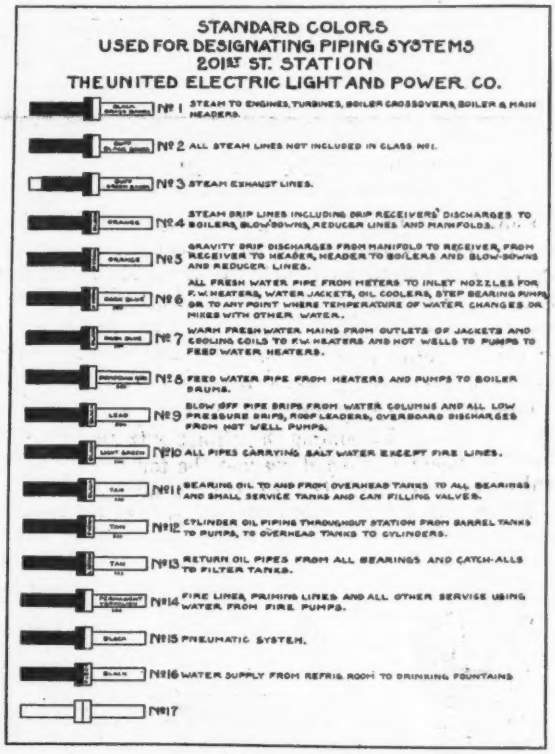
Then we have also the harmful insulators to deal with in boilers. Scale, as we all know, is the worst kind of an enemy in the economic operation of the boiler plant. It is an insulator between the coal pile and the output of the plant. Treatment of the feed water and the use of different mechanical scale removers must be resorted to and used continually if results are to be obtained.

Soot and dirt are also harmful insulators and the keeping of all the outer surfaces of shells and tubes clean will have its own reward.

Steam condensers of the surface type used in connection with condensing engines must also be kept free of scale or the water will not condense the steam and the vacuum will be lower than it would be if the water were allowed to get next to the metal of the tubes.

Color Scheme for Identifying Pipe Lines

THE United Electric Light & Power Co., New York City, has painted all pipes in its new 201st Street generating station with symbolic colors which are interpreted by charts posted in conspicuous places. One of the charts is reproduced herewith. On the original chart the pipe sections are shown in symbolic colors. For instance, steam mains, boiler crossovers, boiler and main headers and steam-supply pipes leading to prime movers are painted black and bound with brass bands; all other steam-supply lines are painted buff and wrapped with black bands; pipes carrying exhaust steam are painted buff and wrapped with green bands; steam drip lines, including drip receivers' discharges to boiler blow-downs and reduced lines leading to manifolds, are colored orange and the flanges painted black. Gravity-drip discharges from manifolds to receiver and from receiver to headers, boilers, blow-downs and reducer lines are also painted orange, but are provided with permanent vermilion flanges. Pipes carrying fresh water from meters to any point where the temperature of the water is changed or mixed with other water are painted blue with permanent vermilion flanges; mains carrying warm fresh water from outlets of jackets and cooling coils to feed water heaters are also painted blue but are provided with black flanges; feed water from heaters to boiler drums is conveyed through pipes painted Pompeiian red; lead-colored pipe with black flanges is connected to blowoff pipes, drips from water columns and all low-pressure drips, roof leaders and overboard discharges from hot-well pumps, etc.; salt water except for fire lines is conveyed through pipe colored light green with black flanges; fire lines and all pipes drawing water from the fire-protection main are painted permanent vermilion. All oil pipes are painted tan, those conveying bearing oil being equipped with black flanges, those conveying cylinder oil being provided with permanent vermilion flanges, and the return-oil pipes being designated by light-green flanges. Pipes used in the pneumatic system are painted black, while lines conveying drinking water are painted black with permanent vermilion flanges.—Electrical World.


STANDARD COLORS
USED FOR DESIGNATING PIPING SYSTEMS
201ST ST. STATION
THE UNITED ELECTRIC LIGHT AND POWER CO.
№1 STEAM TO ENGINES, TURBINES, BOILER CROSSOVERS, BOILER & MAIN HEADERS.
№2 ALL STEAM LINES NOT INCLUDED IN CLASS №1.
№3 STEAM EXHAUST LINES.
№4 STEAM DRIP LINES INCLUDING DRIP RECEIVERS' DISCHARGES TO BOILERS, BLOW-DOWNS, REDUCER LINES AND MANIFOLDS.
№5 GRAVITY DRIP DISCHARGES FROM MANIFOLD TO RECEIVER, FROM RECEIVER TO HEADER, HEADER TO BOILERS AND BLOW-DOWNS AND REDUCER LINES.
№6 ALL FRESH WATER PIPE FROM METERS TO INLET NOZZLES FOR F.W. HEATERS, WATER JACKETS, OIL COOLERS, STEP BEARING PUMPS OR TO ANY POINT WHERE TEMPERATURE OF WATER CHANGES OR MIXES WITH OTHER WATER.
№7 WARM FRESH WATER MAINS FROM OUTLETS OF JACKETS AND COOLING COILS TO F.W. HEATERS AND HOT WELLS TO PUMPS TO FEED WATER HEATERS.
№8 FEED WATER PIPE FROM HEATERS AND PUMPS TO BOILER DRUMS.
№9 BLOW OFF PIPE DRIPS FROM WATER COLUMNS AND ALL LOW PRESSURE DRIPS, ROOF LEADERS, OVERBOARD DISCHARGES FROM HOT WELL PUMPS.
№10 ALL PIPES CARRYING SALT WATER EXCEPT FIRE LINES.
№11 BEARING OIL TO AND FROM OVERHEAD TANKS TO ALL BEARINGS AND SMALL SERVICE TANKS AND CAN FILLING VALVES.
№12 CYLINDER OIL PIPING THROUGHOUT STATION FROM BARREL TANKS TO PUMPS, TO OVERHEAD TANKS TO CYLINDERS.
№13 RETURN OIL PIPES FROM ALL BEARINGS AND CATCH-ALLS TO FILTER TANKS.
№14 FIRE LINES, PRIMING LINES AND ALL OTHER SERVISE USING WATER FROM FIRE PUMPS.
№15 PNEUMATIC SYSTEM.
№16 WATER SUPPLY FROM REFRIG. ROOM TO DRINKING FOUNTAINS
№17

PIPE COLOR CHART

HALF A PART per million of iron in water is detectable by taste, and more than 4 or 5 parts makes water unpalatable. In some mineral springs iron is the constituent which imparts a medicinal value to the water but ordinarily it is undesirable. More than 2.5 parts per million in water used for laundering makes a stain on the clothes. Iron must be removed from water from which ice is made, or a cloudy, discolored product will result. An iron content of over 2 or 3 parts per million in water used in the manufacture of paper will stain the paper. Iron is harmful in water used for steaming, for it is in equilibrium with acids which inside the boiler become dissociated, with the result that the free acids corrode the boiler plates but the amount of iron carried in solution by most waters is so small that the damage it does to steam boilers generally amounts to little.

Waters having a high iron content have in some places, where they have been used as city supplies, caused an immense amount of trouble and expense, for they favor the growth of Crenothrix to such a degree that the water pipes become clogged with the iron sheaths of that organism. The removal of iron from water is sometimes easy and sometimes very difficult. (Water-Supply Paper 273, U. S. Geological Survey.)

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Elevator Valve Accident

FIGURE 1 SHOWS a double piston elevator valve used on a Smith & Haldeman elevator machine, having no pilot valve and using no pressure tank, but having a large standpipe 10 in. in diameter by 6 ft. high near the machine on the water supply pipe, valves are arranged so this machine can be run on pressure from the city main or from the elevator pump. A gear and rack, not shown in the illustration, are connected to a vertical rod having the "tappets" or safety stops at the top and bottom which are operated by coming in contact with the crosshead of the machine when it reaches the top or bottom.

When this valve worked properly, it would reverse automatically at both the top and bottom. As it was a

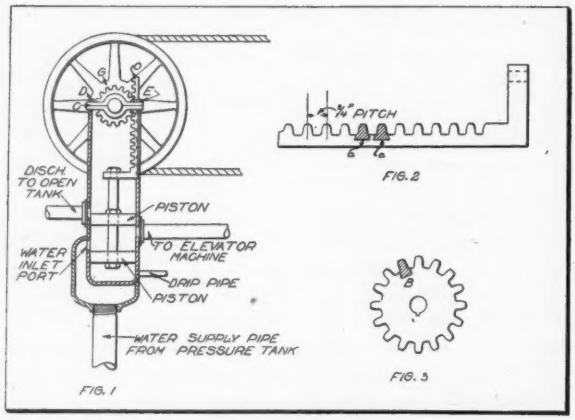


FIG. 1. DOUBLE PISTON ELEVATOR VALVE
FIG 2. TEETH REPLACED IN RACK
FIG. 3. TOOTH REPLACED IN GEAR

high speed freight machine, the sudden blow which the safety stop received, would throw the valve over the neutral position and start the car with the same speed in the opposite direction.

Just what caused the teeth to be broken in the rack and gear, is a complete mystery. By chance I was within 50 ft. of the machine, and an employe about 10 ft. from it, when a cry to stop the car arose and I succeeded in closing the stop valve by the time the car had reached the fourth floor on its way up, having reversed at the bottom and started back as I reached the valve. Had it reached the top or fifth floor, what might have happened can only be conjectured. Possibly no damage would have resulted, if the teeth in the rack were not then broken, as the closing of the inlet port and opening of the discharge port, would keep the shaft T in its bearing while raising the rack and valve to such a position; but the valve could be only partly opened to discharge from the machine and the car descended very slowly. When the wheel was moved to open the valve it was found that 3 of the 4 cap bolts D and E, were broken off. The cap C covers the gear G as well as the 2 bearings, one each side of it, and the rack bar protrudes up through the cap. The cap, being loose, would be thrown over with the edge meshing in the teeth of the rack if the wheel was moved to the starting position; but as this edge was not broken or even battered, it is hardly possible that it caused the breaking of the rack, or gear teeth. Two teeth were broken in the rack and one in the gear. The accident happened Saturday evening, no machine shop handy, 500 miles from the manufacturer, which meant a week's delay for new parts. With a few tools the valve was taken apart and the gear removed from the shaft. No obstructions of any kind were found in the ports, though one of the packing leathers was badly cut on one side. New leathers were put on and with a hack saw, cold chisel and file, dovetail notches were cut in the rack and gear and a piece of key steel was filed up to fit the tapered dovetailed slot, driven in tight and riveted over on the end, the end edges being beveled for this purpose. This made a neat job. The old bolts were easily removed and others substituted. The job was completed and the car in operation in 3 1-2 hr. It ran for 6 weeks before a new rack and gear were put on. Probably it would have run much longer, but I did not consider it as safe as a new rack. I have repaired many gear teeth in this manner since, and I think dovetailing and riveting in the teeth does not weaken the rack or gear so much as it would to drill holes through and fit and rivet in pins to form a tooth; then, too, a file, hacksaw, hammer and cold chisel are more easily operated than a breast drill, which is not always at hand and drilling 12 or more holes through a 1-in. casting by hand is no small job, and with a "solid disc" gear the hole would have to be tapped and the pins threaded to make them hold, to say nothing of cutting the rack bar in two with so many holes, with no chance for a reinforcement piece to be put onto the back when the bar slides in a guide slot. a, a in Fig. 2, show the new teeth set in the rack bar, while B in Fig. 3 shows the tooth set in the gear.

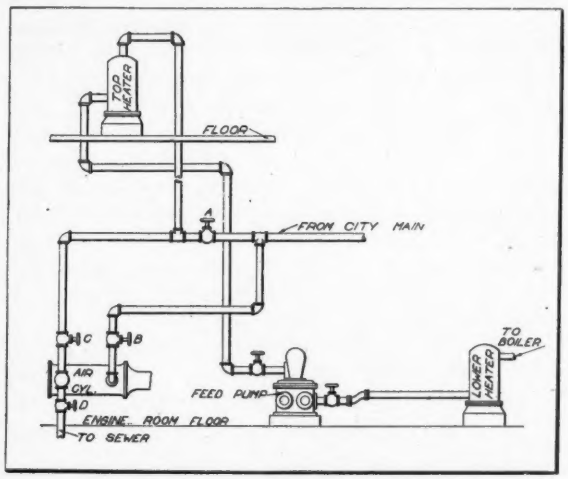
R. A. CULTRA.

Jacket Water for Boiler Feeding

WE ARE using city water for cooling the air cylinder on the air compressor in our plant and for a long time this water was run to the sewer. To do away with this expense we decided to use the water for boiler feeding. The piping is arranged as shown in the illustration.

We have 2 closed feed water heaters. Cold water

is run to the top heater from the city main, then is pumped through the lower heater into the boilers. To circulate the water through the air cylinder jacket into the top heater, valve A is closed and valves B and C are opened. Should the air compressor not be in operation, valves B and C are closed and A is opened. If the heater should be out of working order and the air



PIPING USED FOR FEEDING JACKET WATER TO BOILER

compressor must be in operation, valves A and C would be closed and B opened and water run to air cylinder, and valve D is regulated to drain the water to the sewer during this time.

With this arrangement the water bill is much lower.

H. A. JAHNKE.

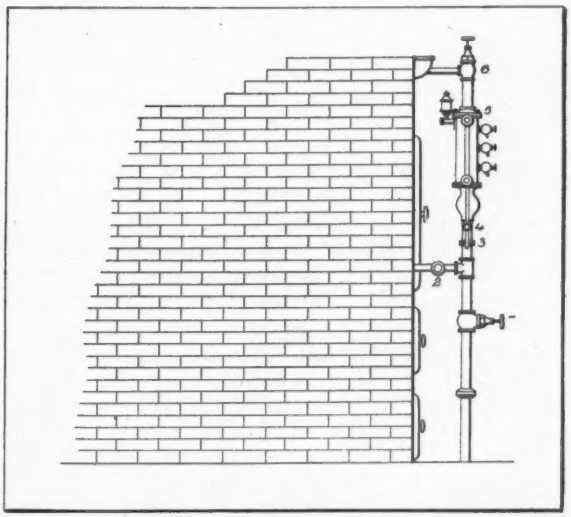
Installation and Use of Water Columns

THE FOLLOWING description of the installation and operation in practice of water columns for steam boilers, illustrates the methods that I have adopted for the care of 6 boilers in the plant that I have charge of, and as good results are secured for the conditions mentioned, there seem to be good reasons for recommending them to others. It is a plain description of actual experience, and not a theoretical assumption of what ought to be done.

These are horizontal, return tubular boilers, 66 in. in diameter, each containing 96 3-in. tubes. The height of these columns from the boiler room floor is determined by the height of the upper row of tubes. When water shows in the glass gage, it is practically 3 in. deep over the upper row of tubes, measured at the manhole. The boilers were slowly filled with cold water after the columns were set by this rule, as closely as could be determined by outside measurement. If their position proved to be incorrect, they were re-set in accordance with this rule. When in service, the low water alarm blows when the water shows 2 in. high in the glass, thus giving 5 in. over the tubes. This is always assumed to be the safe limit, and if it were not possible to raise the water level quickly, and stop the whistle, the fire would be banked and the water column shut off. As there are 6 ways of feeding these boilers, they are always well supplied.

Brass pipe was used for all connections shown in the illustration, except the pipe below the drip valve. The lower connection is made into the right-hand side of the front head, about 1 ft. above the lower part of the shell. It consists of a nipple 12 in. long, on the end of which is a tee with a brass plug in the outer end. The next nipple extends to the right through a slot in the shell, into the brick setting, followed by an ell and another nipple, to which is attached a globe valve 2, connected so that pressure acts on top of the disc when it is closed. This piping is not built solidly into the mason work, but ample space is left around it so that it can be renewed when necessary. None of the weight of the water column rests on this pipe, as the space around it is filled with asbestos, which can be easily removed.

Valve 2 is followed by a short nipple and a heavy, rough, brass tee, the upper outlet of which carries a nipple about 6 in. long. This supports an ordinary flange union, 3, which is packed with sheet packing. This is followed by another nipple that carries the column, the opening in which was bored and tapped for a



WATER COLUMN CONNECTIONS

larger pipe than the makers designed it for. The side opening usually provided was closed with a cast-iron plug. The small pet cock that is frequently found in the lower water gage fixture was removed, and a brass nipple inserted, followed by a globe valve, 4.

The cap on the top of these columns is held in place by 4 bolts, which must be put in from the bottom, thus leaving the heads downward. It was difficult to get the nuts on owing to the shape of this cap, hence longer bolts were secured, and pieces of pipe were cut off in a lathe, to secure square ends, to serve as elongated washers, thus bringing the nuts high enough to be free from this circular molding as shown at 5. Valve 6 is of the angle type, connected so that when closed, pressure acts on the top of it. There is a globe valve in this pipe line near the boiler (not shown in the illustration) connected so that pressure acts on the face of the disc when closed, therefore the stem of it can be packed while pressure is on the boiler, and it also makes it possible to pack the stem of 6 under the same conditions.

There are valves in both top and bottom connections because the column is fitted with a high and low water alarm, which is kept in good working order. If a float becomes water logged, or a connection wears out and fails in service, the fire can be banked and these valves shut, thus relieving the column of all pressure. By taking out 4 bolts at 3 and 5, the column is liberated and can be quickly repaired from parts kept in stock for this purpose. On side of the packing in 3 and 5 is covered with graphite, therefore each gasket can be used several times. If the connections were not fitted with valves, it would be necessary to remove all pressure from the boiler and allow the water to run out before repairs could be made.

The following routine could not be practiced without these valves. When these boilers are to be fired up in the morning, the first thing done is to open 6, 2 turns of the wheel. As the drip valve 7 is open, steam blows down through the column; as there is no water there, the low water alarm is tested by it. The next move is to open 2 to the same extent, and as the drip pipes are maintained full size to the sewer, the connections are well cleared of all sediment. Closing 7 causes water to rise in the column until the high water alarm blows, thus proving it to be in good order. The blowoff valve is then opened, until the water level is brought down to 2½ gages.

At night, after the last engine is shut down, a large injector is started and the water level raised until the high water alarm blows, then 2 and 6 are closed and 7 opened in the order named. This tests both high and low water alarms again, and if not in good order, they are repaired. By opening 2 and 6 2 turns of the wheels, the valves are given full capacity, and if an accident should happen to the column or its trimmings, they can be quickly closed. When a gage glass breaks 2 is closed while the fireman stands on the boiler room floor, and this stops the flow of water, after which he gets a ladder and closes 6.

I formerly had valves in both top and bottom connections installed so that pressure acted on the under side of the discs; but as soon as they cooled at night, the hard rubber discs would contract, allowing steam and water to escape, and in a short time they leaked badly, making it necessary to empty the boilers, use a valve file to repair the seats and put in new discs. This is not required since pressure holds the discs firmly to the seats, regardless of the changes in temperature.

By removing the brass plug in the tee next to the boiler head, it is possible to run a rod through the connecting nipple into the boiler, thus removing sediment if it ever collected there; but as none has appeared during 20 yr. service, it may be assumed that a continuation of present practice will keep them clean. As all weight of the column and trimmings rests on the drip pipe below 7, which discharges into a line that is laid below the boiler room floor, they are firmly and safely supported.

W. H. WAKEMAN.

(In the final report of the Boiler Code Committee of the American Society of Mechanical Engineers, which is today recognized as the highest authority on the subject of boilers, the ruling on valves in gage column connections is as follows:

"No water glass connection shall be fitted with an automatic shut-off valve. When shut-off valves are used on the connections to a water column, they shall be either outside screw and yoke type gate valves or stop cocks with levers permanently fastened thereto, and such valves and cocks shall be locked or sealed open."

Mr. Wakeman's connection is directly contrary to the above rule, and we do not recommend it. That such a connection and practice has not met with disaster in 20 yr. of operation, speaks well for the men who have had charge of these boilers.—EDITORS.)

Expansion vs. Regulating Valves

IN READING the answer to R. F. B.'s questions, I was struck by the persistence with which even well posted refrigerating engineers call the ammonia regulating valve, the expansion valve. There seems to be a prevalent idea that in passing through the so-called expansion valve, the ammonia in some mysterious manner causes the refrigerating effect.

An engineer with a battery of boilers, the water line to each being provided with a regulation valve, would not think of calling these valves expansion valves nor of crediting them with the generation of steam; but the regulating valves to the different ammonia units or coils are called expansion valves and are supposed to produce the refrigerating effect.

The fact is, the expanded ammonia gas has so little refrigerating effect as to be entirely negligible. It is only the liquid ammonia in the coils that absorbs any amount of heat, and in absorbing this heat a small part of the liquid ammonia is converted into gas just as a part of the water in the boiler is converted into steam by the body of water in the boiler absorbing the heat from the furnace.

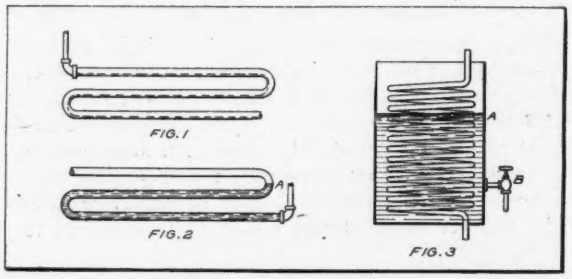


FIG 1. TOP FEED TO COOLING COILS
FIG. 2. BOTTOM FEED FIG. 3. SUBMERGED COIL

Ammonia gas is the result of the refrigerating effect and not the cause of it, just as the steam is the result of the water absorbing the furnace heat and not the cause of it.

It is often noticed that different refrigerating plants of the same rated capacity give widely differing results. This is due in a large measure to the amount of transmitting surface in the system in direct contact with the liquid ammonia on one side and with the circulating medium (brine or calcium) on the other.

Here are 3 methods of furnishing liquid ammonia to the transmitting surfaces that may be briefly named as top feed, bottom feed and the submerged coil.

Figure 1 shows the top feed. Here the liquid ammonia passing through the regulating valve flows along

the bottom of the pipe so that only about half of the coil is really in service. Care must be taken not to feed the ammonia so fast that liquid will flow into the suction header and be drawn over to the machine as this will cause trouble with the packing and rods.

Figure 2 shows the bottom feed and while it looks better it has a very great fault. The bottom pipes may be full of liquid ammonia and working to good advantage; but, should the surface of the liquid be at any bend as at A, the gas bubbles passing up from below would carry over liquid ammonia with its attendant evils. Figure 3 shows the submerged coil. This is a brine or calcium coil submerged in the liquid ammonia. The brine or calcium circulates through these spiral coils, of which there are 3 or more in a cast-iron or steel shell. The ammonia regulating pipe enters at B, below the liquid level. The liquid ammonia is carried as high as possible.

The large disengaging surface, A, ensures quiet vaporization, and the submerged coils furnish the largest amount of transmitting surface for the unit length of pipe. FRANK MIDDLETON.

The Fallacy of Kinks at Times

I WILL cite the following instance that happened within my knowledge as an example of the above. The man that was full of kinks, etc., was given the job of overhauling the valves on a 12 by 7½ by 12-in. Worthington duplex pump of the outside plunger end packed type. This man held a first class Massachusetts engineer's license, and was considered to have a good knowledge of steam engineering in general.

The pump had metal valves, and the seats, which were metal, were cut badly. There was a good lathe in the plant that could be used for this work. The engineer removed the valves and refaced them in the lathe as they should be done. Then his kinks got the better of him and he proceeded to face the valve seats without removing them, by the use of a broken piece of file attached to a round disk of wood of the proper size, which was in turn attached to a common bit-stock by the use of a bolt for a spindle.

After a considerable amount of muscular work with this device, he scratched out some circular pieces of emery cloth, with a pair of dividers, and fastened them to a wooden disk and bit-stock, in a similar manner, as he had previously used the broken piece of file, for the purpose of giving his job a good finish.

Anyone who has had any machine shop experience can easily imagine what kind of a job this was. It is extremely difficult to face any valve or valve seat properly with this class of devices, especially so when they are to work under a water pressure of 160 lb. per sq. in.

Well, he spent 2 weeks, of 6 full days each, of hard work on the valves and seats and considered that he had done a first class job.

His wages were $3.25 a day, which made the job cost $39 for labor alone. In 2 or 3 months, the pump was leaking as badly as ever, making it necessary to repair the pump again; but this time a different man was put on the job, an amateur mechanic at $2.25 a day, that was working about the plant to learn to be an engineer, and he knew nothing about kinks.

He started on this job at 7:00 a.m., taking out the valves and pulling the valve seats out by the use of a bolt screwed into the center of the web in place of the valve stem with a strap across the top of the valve chamber.

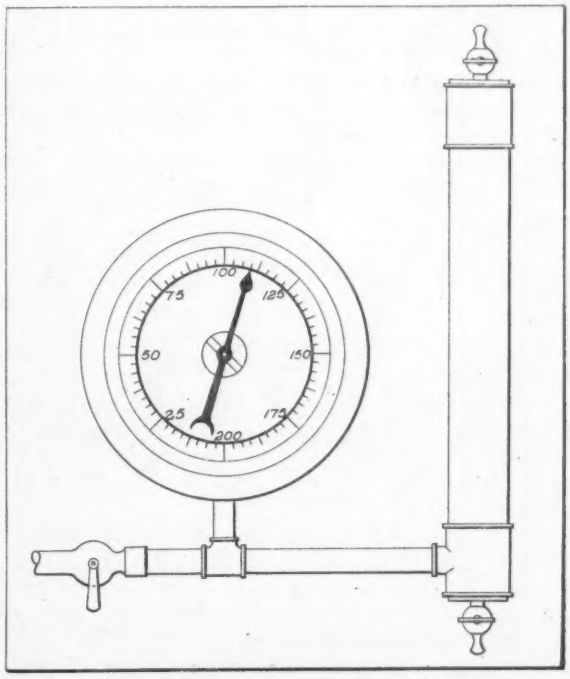
At 5:00 o'clock that same afternoon, the valves and seats had been refaced in the lathe and the job was completed properly, the pump being in first-class condition.

This pump has now run for over a year since being repaired the last time, and the valves have not started to leak any thus far, at a cost of only $2.25 for a year and more as compared to a cost of $39.00 for 3 months.

My idea is that there is generally only one right way to do any job, and that is always the most economical in the long run. J. L. T.

Air Chamber for Pressure Gage

IN CONNECTION with our hydraulic elevator pumping system we have one small triplex pump used for 2 different services, one for Sunday and night work and another for pumping direct into the freight elevator cylinder for lifting safes; consequently the gage for that pump had to be tapped in the discharge line, which brought it quite close to the pump. This caused the gage to jerk at every stroke of the pump unless we had it



CONNECTIONS OF AIR CHAMBER TO GAGE

throttled down very close with the line cock, this would cause the cock to clog occasionally. To remedy this difficulty I extended the pipe leading to the gage and fitted up an air chamber to take up the shock. This was made by using a 1 by ¼-in. tee, a 1 by 8-in. nipple, 1-in. collar, 2 1 by ¼-in. bushings and 2 ¼-in. pet-cocks. The pet-cocks were put on to drain the chamber in case it got filled with water. This rig relieved the gage so that the line cock could be kept wide open and the gage remained steady. L. M. JOHNSON.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Effect of Keying Up, on Clearance

IF YOU key up on a crosshead having strap connections what difference will it make to clearance on head end?

2. If you key up on crosshead with any other kind of connection, what will it do?

3. Is there a slot in the eccentric? Where is it? What is it for?

4. In the case of a butt joint, would 2 plates of same size do just as well as a large plate inside and a small plate outside? If so, why have different sizes?

5. If you rebabbit a bearing and after the metal gets cold you find the babbit loose in the box, what is the trouble?

6. If you key up on both crosshead and crank end, does it make any difference in the clearance?

7. If you key up on crank end only, what difference will it make?

8. If you had an open heater and were getting water at a temperature of 200 deg. F. and you wanted it hotter, what would you do?

9. How hot can you get water from an open heater?

10. How hot can you get water from a closed heater?

11. How can you tell whether an eccentric moves in a straight or curved path? J. W. D.

ANSWERS

IN KEYING up the crosshead with a strap rod end, the head end clearance is increased because the front box is solid against the end of the rod, and as it wears, the distance from the center of the crosshead to the center of the crank becomes less, pulling the crosshead farther from the cylinder. This is considering the crosshead end only.

2. If the engine has the slotted end rod, the back box is stationary, and the front box is keyed up. The wear on the back box will tend to make the rod longer, and will increase the clearance on the crank end and decrease it on the head end.

3. There is a slot in the eccentric used with the Rites, Robb-Armstrong, Sweet, and other governors in which the eccentric moves across the shaft in controlling the valve action. These eccentrics have a projection on one side which is connected to the governor, and there is a slot in the body of the eccentric which allows it to swing back and forth, changing the eccentricity of the eccentric.

4. Two cover plates of the same width in a butt strap joint would not do as well as one wide on the inside and a narrow one on the outside, for the reason that it would make the joint stiff, and any bending or tearing stress would occur at the line of outer row of rivets, which would cause the plate to crack at this point. In the other construction, the bending stress is more equally divided through the full width of the joint, which in a properly proportioned joint gives a higher efficiency than the boiler would have if both plates were of the same width.

5. Loose babbit in the shells might be caused by one or more of several causes. If the babbit is not hot enough, or the bearing shell is cold when the babbit is poured, it may become chilled and not run into the grooves which hold it tight as it should. Another cause is, there may not be proper grooves or dovetail slots cut in the shell to hold the babbit in place. The usual tin base babbit shrinks in cooling; but babbit having a large per cent of antimony has less contraction in cooling, or may even swell or expand in cooling, which would make the babbit loose when cold. If the babbit is loose, it may be pened tight and bored to fit the shaft, or if the shaft is used for a mandrel in pouring, have it warm, and the babbit quite hot, especially if the bearing is a large one, and pour it quickly.

6. In nearly all modern engines, keying up the crank tends to shorten the distance between the centers of the crank and crosshead, while keying the crosshead tends to lengthen the distance between centers. Therefore, the only effect on the clearance is due to the difference in wear of the crank and crosshead boxes, which is so little that practically speaking, there is no change in the clearance due to keying up. In some of the old types, some Corliss, and some other large engines, the rod is lengthened at both ends, due to wear, and this decreases the head end, and increases the crank end clearance.

7. Keying the crank end only would shorten the rod either with a strap and key or wedge outside the pin. If the wedge was back of the back box, however, the rod would become longer, due to keying up.

8. If it is desired to increase the temperature of the feed water above 200 deg. F., open the heater, and see that the distributing trough and pans or trays are in proper condition, so that the water will flow over them in small streams, which will give the steam a better chance to come in contact with the water. Increase the volume of steam entering the heater until it begins to escape from the exhaust head. This ought to raise the temperature up to about 211 deg. F., provided the heater is large enough. If a temperature higher than 211 is required, set the back pressure valve to maintain a pressure of, say, 3 or 4 lb. in the exhaust pipe, which will raise the boiling point of water to about 225 deg. F., which, with plenty of steam, would raise the tempera-

ture of the water to 220 or 224 deg. F. Lagging the heater with asbestos covering also would help to hold the temperature up by decreasing the radiation therefrom.

9. With the exhaust open to atmosphere, 212 deg. is about the limit of temperature for an open heater. If some back pressure is carried on the engine, it may go higher under favorable conditions. In one plant of which I had charge, the exhaust went through a Cochrane heater to the heating system, on which we carried a back pressure of 5 or 6 lb. The temperature of the feed water ranged from 224 to 227 deg. F., during the heating season. In summer, when exhausting to atmosphere through a high pipe, the temperature was 212 deg. F. The heater was set about 3 ft. above the level of the pump.

10. The temperature of water in a closed heater using exhaust steam at atmospheric pressure will seldom go above 190 or 200 deg. F., as there is some resistance offered to the transfer of heat from the steam to the water by the tubes, and also there is generally some oil or scale on the tube surface which further resists the heat transfer.

11. I do not exactly understand this question, but I think it has reference to the eccentric that swings across the shaft or perpendicular to the axis of the shaft to control the valve motion. This moves in a straight line perpendicular to the shaft, but swings in the arc of a circle, the radius of which is equal to the distance from the center of the eccentric to the center of the inertia bar pin to which the eccentric is connected by a lug on one side as in the Rites, Robb-Armstrong and other similar governors. On engines of the Buckeye, Russell and other similar types, the eccentric revolves on the shaft in controlling the valve action, and the center of the eccentric moves in the arc of a circle.

J. C. HAWKINS.

Short Life of Lamps

A LARGE NUMBER of 25-w., 110-v. Mazda lamps are giving me considerable trouble by continual breakage of the filaments. These lamps, which are etched with a letter near the tip, are operated on an alternating-current system, the voltage of which varies at the board from 560 to 610. It should be 590. While this variation of voltage is not so noticeable on the 110-v. side, I still think that this is the cause of my trouble.

Would the etching cause this trouble?

Would the installation of a voltage regulator help any? H. A. C.

A. The etching of the letter on the tip of the lamp has nothing to do with the burning out of your lamps. The trouble is apt to be with your voltage.

Sometimes errors in voltage applied to lamps are due to defective meters or meter transformers. I had a case called to my attention, where lamps were apparently burning out due to high voltage; but the meter registered 120 v. (which was normal) and as it had recently been checked with a precision voltmeter, the trouble was not due to inaccurate instruments. The trouble was finally located, and was due to the fact that while the lighting transformers were 18 to 1 ratio—the meter transformer at the board was 20 to 1. Thus, when the switchboard indicated 120 v., the lamps were getting about 135 v. Check up your transformer ratios, and measure your voltage at the sockets.

A voltage regulator would undoubtedly help your trouble. A slight increase of voltage causes a considerable reduction in lamp life. Even though the periods of high voltage are short, as in the case of a fluctuating supply, the effect is very marked. Many stations are compelled to have more than normal average voltage, in order that the low "spots" do not cause dim light. This is poor practice.

Aside from the marked increase in lamp life, you will profit by the installation of a regulator in other ways—such as better pleased customers due to steady illumination.

The General Electric Co. publishes a bulletin on voltage variations, the title being "Steady vs. Unsteady Voltage." This, I believe, is sent free to anyone desiring a copy, and it might be worth your while to send for it. V. E. JOHNSON.

Boiler Construction Questions

IF THE lower gage cock broke out of the head of a boiler, with full pressure on boiler and fires going, what should be done?

2. Where is the heaviest part of an upright boiler and why?

3. Why are the heads of boilers heavier than the shell?

4. If safety valves of much greater area were used than those commonly used, would it be dangerous? Why?

5. How could you tell whether your boiler surfaces were equally and properly stayed? R. F. B.

ANSWERS

THAT depends on circumstances; it may be stopped temporarily with a pine plug; otherwise, the boiler should be cooled down and properly repaired.

2. Head and tube sheet; see No. 3.

3. Because of corrosive liability from tube and attachment leakage and the unusual fiber stress or breathing due to design.

4. Yes. The sudden relief would cause a molecular disturbance of water which would create water hammer with its attendant results of burned sheets or possible rupture.

5. By accurate measurements and calculations based upon rule for stayed surfaces. J. H. COATES.

Unequal Lap Results in Equal Compression

I HAVE a Corliss engine which requires ½ in. more exhaust lap on the head end than on the crank end to give the same compression.

The piston does not leak and the expansion line does not indicate any exhaust valve leakage. Both steam valves leak a like amount when the wristplate is in its central position.

The excessive lap required on the head end results in a much higher terminal pressure at that end than on the crank end. J. W. D.

A. I take it that in your inquiry, you refer to exhaust lap, although when not specified, steam lap is generally meant in connection with the term "lap."

It sometimes happens that valve setting of an engine is misplaced at some time in its career, and allowed to operate that way for several years. This will usually wear a shoulder at the extremes of travel and more so in the closed position than in the open position.

If this were to happen with too little lap on any certain exhaust valve, any effort to set the valve with the correct amount of lap would cause the valve to ride over this shoulder just preceding closed position when the valve is practically at rest.

The result would be a leakage of the entrapped steam, thus reducing the point where admission begins. Any effort to increase this lap, as you have done, will not help any, for while compression actually begins earlier, and by all rules should run up higher on the card, yet the leakage will be there the same and show a low compression.

This is probably your trouble and the remedy will be to have the port rebored if necessary, or possibly you can scrape the valve or port to a seat. It may be necessary to file and scrape both to do a good job.

A difference in the clearance between the 2 ends will affect this feature on the card to a certain extent. Check up and see if you have the same clearance at each end. Insert a piece of small lead pipe or tubing, or a bundle of heavy fuse wires or electricians' solder will do, in the indicator pipe holes and turn the engine over the centers and then measure the thickness of the compressed lead.

See that your valve gear is "squared up" all right. Look at the travel of the carrier arm and the wristplate and see if they travel the same on each side the center. Take up all lost motion also.

With the valves squared up you will be in a position to put your finger on the seat of trouble with accuracy.

In a case of this kind, an indicator card would assist materially in making a diagnosis of the case.

G. H. WALLACE.

Patching Boiler; Reversing Engine

WHAT IS to be done and what repairs are to be made if you find a 14-in. crack along the side seam of a boiler? What would be accepted by a boiler inspector?

2. What is meant by single and double rivet shear?

3. Give a practical way to connect open and closed heaters to pumps.

4. How would you reverse a common slide-valve engine without removing the steam chest cover?

5. How can the travel of a valve be shortened?

ANSWERS O. H.

SUCH A crack as you mention along the side seam of a boiler, would certainly mean that a patch must be put on, and, properly, that a new plate should be put in as soon as possible. The method of putting on a hard and soft patch is explained in the Jan. 1 Boiler Number, and you will, also, find an article on the soft patch in the Feb. 15 number, and a fuller direction for the hard patch in the Mar. 15 number. A crack 14 in. long would indicate that there was likely to be weakness in the plate along the rest of the seam, and the replacement of that plate should be made as soon as the boiler can be spared.

2. In single shear, the rivet is so placed that if it is pulled apart, it will be cut in 2, once. In double shear, the rivet passes through 3 thicknesses of plate, so that if one plate is pulled out from between the other 2, the rivet would be cut off twice; that is, would be sheared in 2 places.

3. In the case of an open heater, it must, of course, be connected to the suction of the pump, as the heater is open to atmospheric pressure. In the case of a closed heater, it may be connected either to the suction or to the discharge, so that water is pumped through it to the boiler.

4. A common slide-valve engine can be reversed by turning the eccentric on the shaft in the direction that the engine is now running, through 180 deg. minus twice the difference between the angle which the eccentric makes with the crank and 90 deg. To explain this a little more fully, the crank will set at something more than 90 deg. back of the eccentric, in the direction that the engine is to run. The difference between 90 deg. and this angle between crank and eccentric, that is, the heaviest part of the eccentric, is the total angle of advance, so called, and this angle of advance will be about the same when the engine is running in the opposite direction; that is, the eccentric must set so that it will be 90 deg. plus the angle of advance ahead of the crank, in the opposite direction of turning. The engine will not run quite the same reversed that it did in the first place, because of the angularity of the connecting rod, which is changed, but it will run after a fashion.

5. If a valve is direct driven by the eccentric, that is, has straight connection through from the eccentric to the valve by an eccentric rod and valve rod, the only way to shorten the valve travel is to put on a new eccentric, with a shorter throw. If the valve is driven through a rocker arm, the valve travel may be shortened either by making the distance from the pivot of this arm to the end of the valve rod connection shorter, or the distance from the pivot to the eccentric rod connection longer. A. L. R.

Horsepower of Pump Motors

HOW CAN I calculate the number of horsepower required to operate a pump working under given conditions so that I may figure out the size of motor required to drive it? A. R.

A. The horsepower required to raise water a given height is equal to the product of the number of cubic feet of water raised per minute times the pressure in pounds per square foot divided by 33,000. This may also be obtained by any one of the following methods: Divide the product of the number of cubic feet of water lifted per minute times the height of the lift in feet times 144 times 0.433 by 33,000; divide the product of the number of cubic feet of water lifted per minute times the height of the lift in feet by 529.23; divide the product of the number of gallons lifted per minute times the height of the lift in feet by 3958.9; divide the product of 1.0104 times the number of gallons lifted per minute times the height of the lift by 4000.

For the actual horsepower required it is, however, necessary to make the proper allowances for the mechanical losses of the motor and pump, slippage, leakage of water and pipe friction. For these losses we would suggest adding about 20 per cent. O. H. H.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

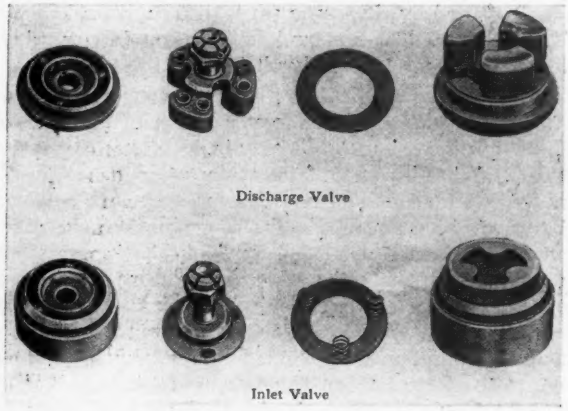
Commutator Lubrication

I WOULD like the opinion of some of the readers regarding the use of paraffin on commutators.

H. G. H.

Air Compressor Valve Breaks

NOTING IN the April 15 issue, the troubles that J. D. D. has been experiencing with discharge valves of an air compressor, I would venture the opinion that the machine is being operated in excess of its rated speed, or that the valve area is deficient.



NEW TYPE OF INLET AND DISCHARGE VALVE FOR AIR COMPRESSOR SERVICE

Breakage at the points indicated can only be due to excessive lift which results in the valve proper striking the plug. To overcome this trouble, I would suggest the employment of valves of the flat-disc type, which have been developed and thoroughly tried out during the past 2 or 3 yr., and are now giving satisfactory results. The illustration shows a type of valve which is interchangeable with the type now being used by J. D. D.

H. L. DEAN.

IN REPLY to the inquiry of J. D. D., page 415 of the April 15 issue, in regard to the breaking of discharge valves on the low pressure side of a 2-stage air compressor, I believe this to be due to lack of clearance between the top of the valve and the plug which seats on top of valve cage. If this distance is not great enough to allow the valve to open fully the port in the cage, air pressure will force the valve hard against the plug without being fully relieved.

If the length of the valve (top or guiding part) is reduced so that when the port is fully opened there will be about ⅛ to 3/16 in. between the top of the valve and the plug, the tension of the spring will overcome the momentum of the valve and if it strikes the plug at all, the blow will be but light.

I do not think that the intake valve could be late enough in closing to cause so sudden a rise in pressure as to break the discharge valves as described, without causing the compressor to run very lame.

H. H. BEUTELSCHIES.

Oil Filter Trouble

IN THE May 1 issue, I note John H. Armstrong's request for information relative to an oil filter. Perhaps the following may be of service to him.

First, I would say that waste is not exactly suitable for filtering purposes because it "packs," as we say, and easily clogs up, this being especially true in the case of a heavy body oil that is cold in the filter. Instead, use what is termed "teased-out" hemp or manila rope, which will not pack and clog. The teased-out rope permits of a free passage of the oil, and collects all the dirt. Besides this, the rope can easily and quickly be cleansed, which cannot be said of the waste. I have used rope in this way with satisfactory results, and can safely recommend it.

I would also say that the place to apply the heat to the filter is in the water space at the base. If the body of water is kept hot, the oil going into it will also become heated and part with most of the heavy impurities contained in it before it reaches the first layer of filtering material. I have obtained oil from a filter, practically the same in construction as that shown in the illustration, which was as clear and as clean as new oil, as far as could be distinguished by ordinary means. Let Mr. Armstrong try the rope-material and hot-water method, and then report his findings to the rest of Practical Engineer's readers.

C. J. MASON.

FREQUENTLY a gas engine which once ran fine becomes less and less lively. When the loss of power dawns on the owner, he recalls that the power loss had been so gradual as to have passed unnoticed, until the lack of sufficient power became so pronounced that he finally realized something required his attention. In such cases it should be noted whether the exhaust is smoky and smelly and whether it was always so. If it is, the most likely place to apply a remedy is in the muffler, the small holes of which will, upon examination, be found to be clogged or almost closed.—Gas Power.

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Fundamental Economy in the Steam Power House

Economy of the power plant begins with the man upon whom the economy of power production depends, not the Chief Engineer, the Superintendent or any of the high priced men essential for the efficient operation of a steam plant, but, in fact, with one of the poorest paid men on the staff; the boiler man, the fireman. His duties are arduous, complex and apparently conflicting, for he must keep up his steam pressure to meet the engine room and heating requirements, or get into trouble; and he must be economical in his consumption of fuel, practice that does not tend to facilitate keeping up steam, or again get into trouble. While this apparent conflict between his duties make them both exacting and responsible, at the same time it demands of the fireman a keen insight into the efficiency of operation of other departments than his own; and such knowledge could easily be grasped, if he once fully realized his duties and opportunities. Instead of the fireman being the target for all complaints and blamed for all wastes and inefficiencies that are not obviously the result of somebody's else error, he should be a most respected employe, a man feared by those who shirk their work and by the incompetents. The fireman knows, or could know, where to lay the blame for nearly all wastes.

The fireman's main duty—in fact, practically his only duty—is to generate steam economically. He must keep up his pressure, but that is only incidental to generating steam. What becomes of the steam after it is delivered to the steam mains under proper pressure is no responsibility of the fireman. If the steam pipes leak, if the engines are wasteful or inefficiencies in the factory create unduly heavy loads, the effect on the fireman's work is simply to increase the difficulty of maintaining the correct pressure. He knows that there is something wrong and, if familiar with his plant, could frequently point out where the wastes occur,—that is, he could do so, if his tasks were not made so laborious, by others or by his own failure to realize just what are his duties and their limitations. Instead of which, he is often blamed for the loss, if it is found that his coal supply is being used up more rapidly than the management considers necessary.

Sometimes he is to blame, it is true, but just as often the real fault is elsewhere. The vindication or the condemnation of the fireman is in reality a simple matter, so simple that it is frequently overlooked. No exhaustive and expensive boiler tests are necessary; not that occasional investigations of such character are not valuable, even essential, but a simple record kept of the quantity of water evaporated in the boiler and the amount of fuel consumed for such evaporation furnishes all necessary data for judgment. The pounds of water evaporated per pound of fuel is the chief matter. It is the gist of the most elaborate boiler test, it is conclusive evidence of the fireman's ability and, if the record is satisfactory, absolves the fireman of all blame.

Such records are simple to keep, require no expensive or complicated equipment for recording; in fact, comparatively inexpensive apparatus can be installed to keep such records automatically, and more reliably, from a practical operating point of view, than boiler tests, which,

no matter what care is taken to conduct them under ordinary working conditions, can rarely be typical.

The fireman must keep his fires in efficient condition, must see to it that his ashes do not accumulate, keep the heating surfaces of the boiler as free from soot as possible, must see that the water level is kept constant. These constitute the arduous details of his duties, but, if these details are attended to and he burns the minimum amount of coal required to maintain the boiler pressure, he has done his full duty. No more can be asked of him and no blame can be attached to him for undue fuel consumption brought about by wastes or inefficiencies in other departments. The rate of fuel consumption cannot be arbitrarily fixed, for each fuel has its own particular evaporating capacity or value, under fixed conditions of consumption, a value that can only be established by careful firing while learning the peculiarities of the fuel, for every fuel has its own peculiarities, which, if realized, stamps the fireman as efficient.

Maintaining constant "pounds of water evaporated per pound of fuel" should be the aim of the efficient fireman, not small fuel consumption, for, if the evaporating value of the fuel is maintained constant, pressure being kept up at the same time, economy in the use of fuel naturally follows.

The Chief may order the trial of a different grade of fuel, but this in no way alters the responsibilities of the fireman. "Pounds of water evaporated per pound of fuel" is all that he has to look out for. The new fuel may not prove economical. That should not affect the fireman, for he is responsible only for transmitting as much of the heating value of the fuel to the boiler contents as his equipment will permit. The price of fuel should not worry him; neither should the rate of combustion that the boiler equipment and the service requires,—reflected in the rate at which the coal pile is diminished,—cause him any anxiety. Such troubles are not his, if he maintains constant pounds of steam per pound of fuel consumed. The heat generated in the combustion chamber may in large part be dissipated up the chimney, but if the rate of evaporation is constant this simply means that his boiler and grate are not proportioned for the fuel employed. His tools may not be satisfactory, but just as long as his output is constant he is doing the best that can be done with them. Improvements may be possible, probably are, but they are beyond the province of the fireman.

To maintain constant the rate of evaporation is no sinecure, however. Efficient firing and clean fires are necessary, but of even greater importance are clean heating surfaces. Ordinarily precautions are taken to protect steam pipes, etc., with coverings of suitable materials to minimize the heat loss from radiation. Excellent practice, but nowhere near as efficacious as clean heating surfaces. In any boiler installation there is being continually deposited on its heating surfaces material that is 5 times as good a nonconductor of heat as asbestos; i.e., the soot from the combustion chamber. No fireman would for one moment countenance protecting any of his boiler heating surface with a ½-in. covering of asbestos; yet this would reduce the efficiency of his boiler no more than permitting soot to accumulate to a thickness of 3/32 in. A 3/32-in. layer of soot on all heating surfaces would rarely be allowed to accumulate by even the least efficient fireman, it is true, but there are many boilers being operated where the mean thickness of soot on out of the way corners of heating surface is as great as this, or greater. To further complicate matters and increase the loss due to the presence of soot, such deposits are invariably thickest on surfaces where the intensity of heat is comparatively low, just where every facility for the transfer of heat is most urgently needed, where the heat transfer to the boiler contents is less rapid than at points where the difference between temperatures within and without the boiler is greater. It is no very difficult task to keep the heating surfaces lying in the direct path of the products of combustion, where the heat is most intense, clean; the great difficulty is to guard against soot accumulating on the comparatively cool sections.

The fireman who keeps his boiler free from soot deposits, particularly in the remote corners, and keeps the rate of evaporation constant is doing all that he can possibly do, is a true "economist" of the steam power plant and is discharging his duties and responsibilities most efficiently. If there is one employe of the power plant whom it would pay the management to employ on a "bonus salary" system, it is the fireman. The "bonus" being dependent upon the constancy at which he maintains the rate of evaporation—that is, the pounds of steam generated per pound of fuel consumed.

AT THE Panama-Pacific Exposition now open at San Francisco, the United States Geological Survey has an interesting exhibit showing how its work is done. This occupies a space 62 by 78 ft., in the Palace of Mines and Metallurgy, and is between the exhibit of the Bureau of Mines and the Alaskan exhibit, in both of which the Geological Survey has had a considerable part. The central feature of the exhibit represents the study of an undeveloped district in the arid west by the Survey; topographers at work with instruments, geologists stripping a bed of coal and taking a sample for analysis, while others are studying the rocks for mineral deposits. The work of gaging the stream with an automatic gage to determine the amount of water available, is also shown, and in the background the workers' camp and pack train.

In the second scene is shown the district after development, showing the power plant which has been located on the stream, and the use of the water for irrigation after it has passed the plant. The coal bed is also being mined, and an oil field is under development, with mining and milling in progress in the mountains.

Besides these scenes, there are numerous views showing the different kinds of survey work, and how they assist in developing the country, with charts giving the statistics of mineral production in the United States, and the increase of this production from 1880, at the time the Survey was organized, up to 1913. There are, also, exhibits of raw material, and of the things that are made from this raw material after it has been mined and worked in mills and factories. The power and fuel resources of the United States are illustrated by maps showing the distribution of the shale from which oil is derived, as well as the distribution of coal beds.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

The Ridgway Turbine

IN 1911, the first Ridgway-Rateau-Smoot turbine, which for brevity, is known as the Ridgway turbine, was built and placed in successful operation by the Ridgway Dynamo and Engine Co., of Ridgway, Pa. This turbine, which is of the impulse type, is now built for high, low and mixed pressure and bleeder service and, as shown in Fig. 1, possesses many important features such as, unusually great running clearance, simplicity of design and operation, accessibility, positive and simple governing mechanism, high steam economy, accurately

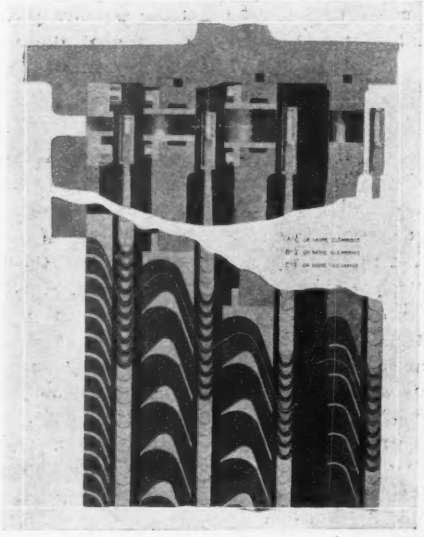


FIG. 1. SECTION OF NOZZLES, BUCKETS AND WHEELS

machined and strong bucket construction, self shrouding buckets and a short shaft claimed to eliminate temperature stresses and allow quick starting.

As the steam issues from the first set of stationary nozzles, it strikes the entrance edge of the first row of buckets and passing through them, its direction is changed, giving up energy to the buckets and driving them forward. While the velocity of the steam is reduced during its passage through the buckets, no expansion occurs, hence its pressure is the same on both sides of the disk, and is uniform in the entire space between the diaphragms. Due to this uniform pressure there is no tendency for the steam to leak past or around the buckets, consequently there is no necessity for close running clearances between buckets and nozzles or casings. In fact, these clearances range in the various sized machines from a minimum of 3/16 in. axially and ½ in. radially, to a maximum of ⅜ in. and 1 in. respectively.

The casing and head of the stationary element are split horizontally, so that the upper half may easily be removed in case it ever becomes necessary to open the

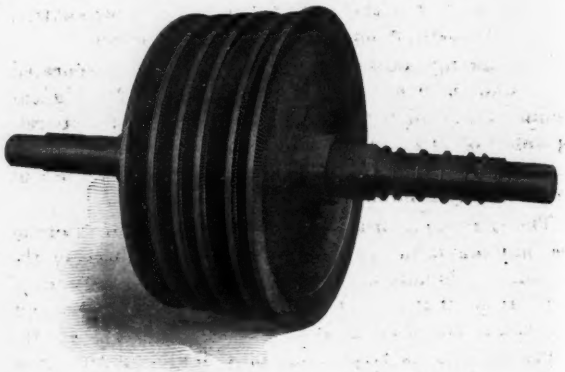


FIG. 2. COMPLETE TURBINE ROTOR

turbine. The diaphragms are also split and the top halves are fastened to the top of the casing and lift with it.

The nozzle construction varies in the various diaphragms, depending on the required area. Nozzles of small area such as are used in the first stages are solid castings of special alloy, machined and bolted in place.

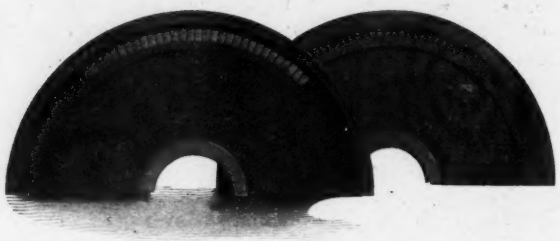


FIG. 4. FRONT AND BACK OF HALF DIAPHRAGM WITH CAST-IN NOZZLES

In later stages, the blades forming the nozzles are cast in place in the diaphragm, and extend all or part way around its periphery.

Rotating Element

THIS CONSISTS of a shaft of high-carbon steel on which are mounted keyed wheels of flange-steel, machined and carrying buckets secured to the periphery of the wheels by rivets. Each bucket carries its own

shroud and when assembled on the wheel is in rigid contact at the outer end, with the adjacent buckets, a form of construction stated to prevent the vibration of individual buckets, and their consequent breaking, and to facilitate the removal of any single bucket without disturbing adjacent buckets.

Governing

Regulation of the flow of steam is accomplished by means of a throttling flyball governor mounted on the end of the main turbine shaft. When in operation, the flyballs which are carried on tool-steel knife edges, have a large amount of energy giving positive and close control. The main governor thrust bearing is provided with 2 ball bearings operating in oil, while the spring thrust is taken care of by tool-steel cup points, so that no lubrication is required. An auxiliary spring connected to the bell crank underneath the governor provides speed adjustment, while the turbine is in operation.

Depending on the conditions of service, various combinations of valves are used. For high pressure service, the main valve is usually of the double balanced poppet type, feeding an arc of nozzles sufficient to carry full load. A second valve of the piston type, mounted on the same stem, supplies a separate set of nozzles for carrying overloads, but does not open until the main valve reaches full load position. The construction of these valves is such that, if for any reason the turbine exceeds normal speed, the main valve can always close and shut off the entire steam supply. An additional hand-operated valve is furnished, if required, for noncondensing service, which bypasses the first and sometimes the second stage, but keeps the turbine under full control of the governor.

Ridgway turbines are furnished direct connected to alternating or direct-current generators.

Wendell Centrifugal Coal Drier

THIS machine, used for the drying of washed coal for coking purposes and the smaller sizes of steam and domestic coal, consists in general of the frame, a pair of feed spouts, the container, the discharge hopper for the dried coal and a sluice for the reclaimed water.

The feed spouts, fastened to the inner solid shaft, are driven by suitable transmission so as to revolve at any desired speed independent of the retainer. The retainer, a conical shaped chamber with the outer inclined walls of perforated metal and a bottom provided with openings closed by hinged doors, is driven at a high rate of speed by a hollow shaft independent of the feed spouts. Outside of the inclined wall is a sluice for the disposal of the water.

The hinged doors at the bottom are automatically opened and closed by a pair of cams attached to the shaft which carries the feed spouts, and as the retainer

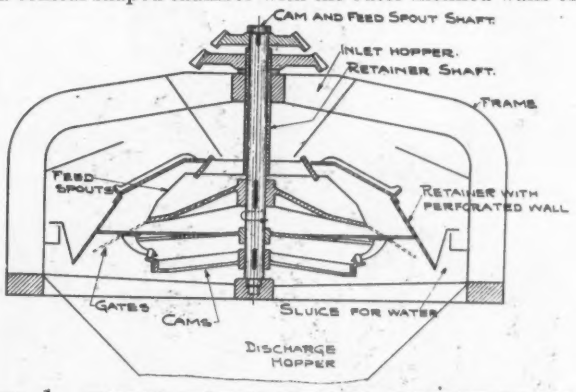


FIG. 1. DIAGRAM SHOWING INTERNAL CONSTRUCTION AND OPERATION OF THE WENDELL DRIER

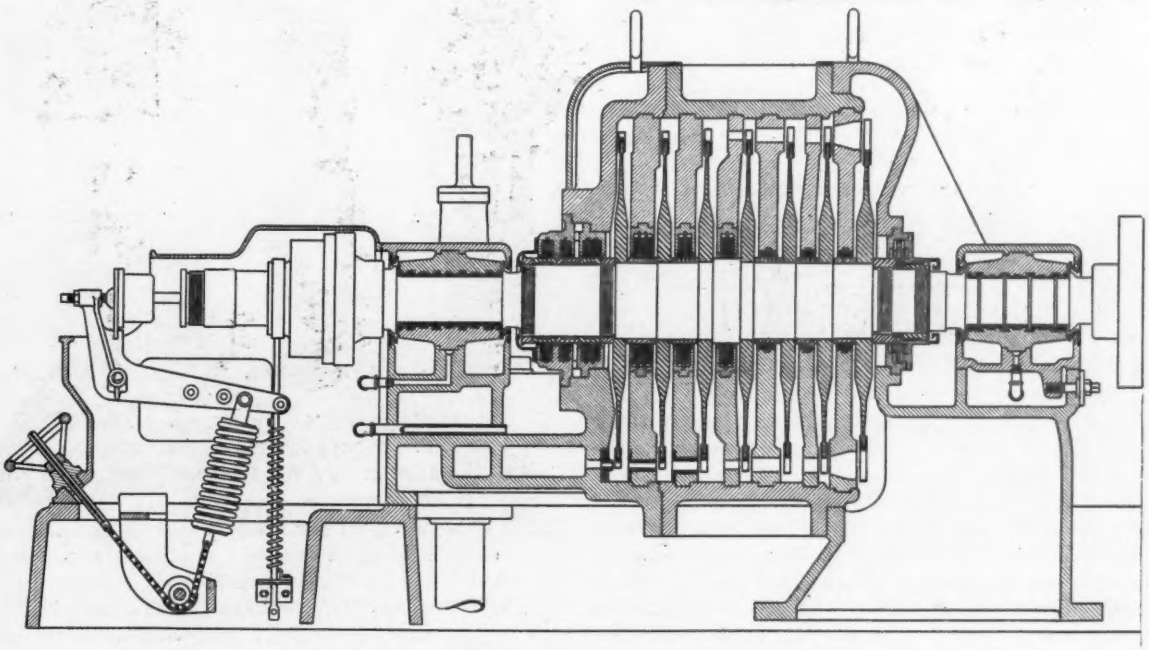


FIG. 3. SECTION OF HIGH-PRESSURE TURBINE

slowly gains upon the cams, the difference of speed being very slight, the dried material is automatically discharged through the door openings, each door opening in its turn. As the door closes, the spout which follows directly behind the cam, fills the empty place in the retainer. Easy discharge of the material is accelerated by the outer wall of the retainer being inclined while centrifugal force makes the discharge almost instantaneous.

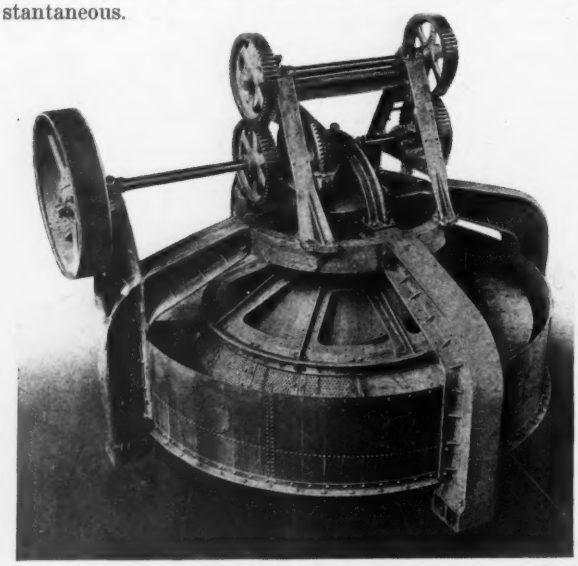


FIG. 2. THE WENDELL COAL DRIER, SHOWING THE FEED SPOUTS, RETAINER AND DRIVING MECHANISM

Among the many valuable features embodied in this machine is that the entire performance is continuous and is accomplished by centrifugal force and gravity; no scraping or plowing devices being used, thereby eliminating excessive wear and power.

Wendell Driers are built by the Link-Belt Co., of Chicago.

Elliott Reducing Valve

TYPE "A" Reducing Valve, made by the Elliott Co., of Pittsburgh, is a combination reducing and relief valve, and is intended for use in installations where the initial pressure of the liquid or gas does not exceed 125 lb. per sq. in.

The liquid or gas at initial pressure enters at the left, Fig. 3, and tends to lift the valve from its seat. This tendency is counterbalanced by the same pressure being exerted in the opposite direction on the tube cap, which is attached to the valve by the valve stem. Full initial pressure is exerted on the tube cap, for the sleeves inserted in the body of the valve and the lower end of the distance piece, fit the valve stem loosely, their function being simply to serve as guides. The exposed area of the tube cap is made the same as the area of the valve, thus the tendency of the initial pressure to move the valve in one way is exactly counteracted by a tendency of equal force to move it in the opposite direction. For this reason the operation of the reducing valve is not in any way affected by any fluctuations in the initial pressure.

The regulation of the reduction in pressure is obtained by balancing the force exerted on the upper side of the main valve against the tension on a pair of springs, by means of an India rubber tube, which is supported at its upper end by the distance piece, and at its lower end by the tube cap. Deep grooves are cut in both distance piece and tube cap, and when pressure is exerted on the inside of the tube the rubber expands into these grooves and makes a leakless joint, for the higher the pressure the more firmly the rubber is forced into the grooves. The rubber tube is reinforced by a number of neatly fitting telescoping rings, which permit it to expand only in the direction of its length. When the valve is wide open the rings are in the position shown in the sectional view. When the valve is fully closed, or partly closed, the rubber tube is extended and the rings are equally spaced along it, as grooves are cut in the rings so that they will maintain their relative position on the tube. As the tube contracts, due to the opening up of the valve, the rings telescope within one another and assume their position as shown. The rubber tube is long in proportion to the range of the valve movement so the space between the rings, even when the valve is closed, is very small.

FIG. 1. TYPE "A" REDUCING VALVE
FIG. 2. TUBE AND TELESCOPING RINGS
FIG. 3. SECTION OF TYPE "A" REDUCING VALVE

The pressure on the low pressure side of the reducing valve, which acts on the upper side of the main valve, will disturb the equilibrium established between the force acting against the lower side of the valve and the tube cap, but this pressure is counterbalanced by the tension on the springs suspended between the yoke thrown over the valve, and the tube case which encloses the reinforced rubber tube and tube cap. In operation, when this pressure exceeds the tension on the springs, the valve is moved toward its seat, which restricts the passage of the liquid or gas, and lowers the pressure on the low pressure side. In this way a balance is maintained between the pressure acting on the top of the valve and the tension on the springs. The tension on the springs can be varied by turning the adjusting

screw to the right or left, consequently the reducing valve is adjusted for any desired reduced pressure by turning the adjusting screw the proper amount.

Any slight variation in pressure on the low pressure side, either up or down, causes the valve to move toward or away from its seat, and the movement is coincident with the variation, for there is no friction to be overcome before the valve can move from one position to another.

The relief valve in the cover is in fact a safety valve, which relieves the pressure on the low pressure side of the reducing valve, should it for any reason build up to a point slightly in excess of that for which the reducing valve is adjusted. With the type "A" reducing valve the area of the relief valve is only slightly less than the area of the main valve, and a small increase in pressure on the low pressure side is sufficient to overcome the tension in the springs, and cause the relief valve to rise from its seat. When the adjustment of the reducing valve is changed, the relief valve is adjusted to correspond, as a change in the former automatically makes the same change in the latter. A change of adjustment is made by simply turning the adjusting screw the proper amount.

When the reducing valve is installed in a steam line, the tube case should be filled with water before the valve is put into service, to prevent the steam from coming in contact with the rubber tube. A tapped and plugged connection is provided in the lower end of the distance piece, for filling the tube case. In operation, the water of condensation drains from the line and serves to keep the tube case filled.

Reducing valves up to and including the 1½ in. size are made of bronze, and the distance piece is made as shown here. Reducing valves larger than the 1½ in. size are made of cast iron, with bronze wearing parts.

Defender Apparatus

IN the accompanying illustrations are shown some of the boiler room apparatus made by the Defender Automatic Regulator Co., of St. Louis, Mo.

Figure 1 is an illustration of the Defender flue gas thermometer made of heavy glass tubing encased in a fully nickel-plated heavy steel case and graduated to be read up to 1000 deg. F. The top of this thermometer is provided with a ring so that, by means of a wire attached thereto, the thermometer can readily be hung in otherwise inaccessible places. When it is necessary to pass the thermometer through heavy brick walls, this top ring can be unscrewed and an extension of ⅜-in. pipe substituted. The instrument may then be inserted any distance into the hot gases. With the mercury bulb encased in an extra heavy case, the heat will be retained for some time after removing the thermometer, thus allowing considerable time for reading.

FIG. 1. DEFENDER FLUE GAS THERMOMETER—READING TO 1000 DEG. F.

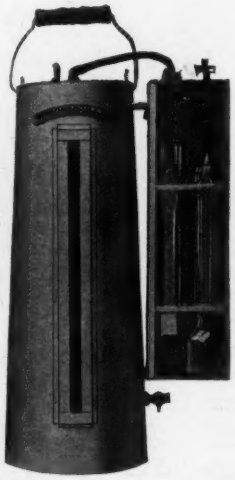


FIG. 2. DEFENDER MODEL B GAS COLLECTOR AND SINGLE-CHAMBER ORSAT

FIG. 3. DEFENDER LEFT-HAND SINGLE-TUBE DIFFERENTIAL DRAFT GAGE

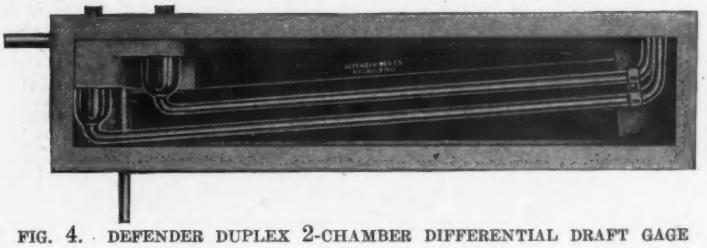


FIG. 4. DEFENDER DUPLEX 2-CHAMBER DIFFERENTIAL DRAFT GAGE

Defender Model B gas collector with single-chamber Orsat for CO_2 readings only is shown in Fig. 2. This combined collector and Orsat apparatus allows a continuous collection of gas for periods of either 8 or 24 hr., depending upon the capacity of the collector. This collector contains a calibrated tube having a 1-in. opening at the top to the atmosphere. The top of the collector has a water cup 1 in. in depth so that as the water is poured therein it fills the collector and forces the gas out and into the Orsat. The gas is drawn into the outer portion of the collector through the calibrated tube which is also used for placing a pressure onto the collector so as to force the gas out and into the Orsat.

The Defender single-chamber Orsat apparatus for reading CO_2 is self contained in a metal case finished in aluminum and has a sliding front, top and back, and, as it is unnecessary to remove the solutions at any time, it

can be shipped and carried ready for use whenever and wherever desired. This instrument is furnished with either glass or pinch cocks.

Excepting for the additional chambers, the general construction of the Defender 3-chamber Orsat is similar to the single chamber unit. A special feature of this instrument is a burette, which is graduated so as to be read to 1/5 of 1 per cent from 0 to 21 per cent. And, as the total length of this burette scale is 3½ in., it allows for easy reading of the percentage of CO, which is always read in a fraction of 1 per cent. The pipettes are of the double bottle type and are self-contained one within the other. When the gas is forced into the inside bottle the solution rises in the outer bottle.

Defender Draft Gages

The Defender single-tube differential and the Defender duplex differential draft gages are made in both the left-hand and right-hand types, covered or uncovered as desired.

The single-tube gage is recommended for use on return tubular boilers while for water-tube boilers where simultaneous reading over the fire and in the last pass are required to obtain the draft loss through the setting, the duplex or multiple gage is to be preferred. This difference of draft reading at different points of the settings of water tube boilers is very essential. Leaks in the boiler settings and short-circuited gases due to damaged baffles will be indicated by a smaller draft loss, while soot accumulations will be indicated by a greater draft loss, and unless the loss of draft through any boiler is shown the cause of the increase of flue gas temperature would be unknown. The Defender left-hand single-tube differential draft gage and the Defender duplex 2-chamber left-hand differential draft gage are shown in Figs. 3 and 4 respectively.

The Defender multiple type draft gage is composed of 2 separate gages mounted on a board, the top gage reading in 0.75 in. of water while the bottom gage reads to 1.0 in. All gages are furnished with a 6-in. length of rubber tubing to connect to a ⅛ or ¼-in. iron pipe leading to the furnace or last pass and thereby protect the gage from breakage in case of an accident to the pipe.

An important feature in the construction of these gages is that the glass tubing is left loose at the top, thus allowing it to expand when used in hot places and save the tube from possible breakage.

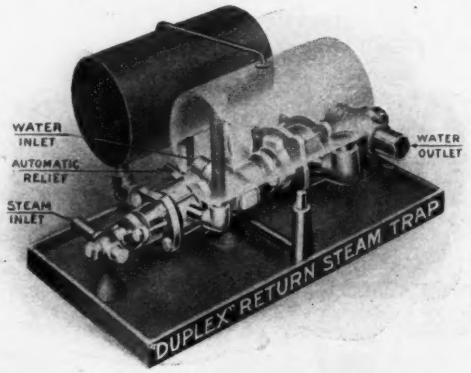
The twenty-fourth annual New Jersey State Convention of the National Association of Stationary Engineers will be held at Trenton, June 3 to 6, inclusive, under the auspices of Trenton Association No. 4. An unusually large attendance is anticipated for the further discussion of the new engineers' license law, recently effective in the State.

A machinery exhibit will be maintained at the Masonic Temple, and extensive preparations are being made for displays of representative power plant products. Elaborate booth arrangements have been perfected, with color scheme in red and white. The local Chamber of Commerce is co-operating with the Association committee to carry out the details of the plan.

The executive committee in charge is composed of J. L. Lightford, William Hirst, W. W. Law and E. A. Corbett.

Duplex Return Steam Trap

THIS is a tilting type trap with 2 chambers, as shown in the illustration, having the steam valves separate from the water valves, and both these operate simultaneously by the movement of the trap which takes place when the receiving drum is filled. By the use of the 2 drums, a constant suction is maintained when used to drain a steam system, since the vacuum is created alternately in each drum, and when used for boiler feeding, an unrestricted flow to the receiving drum may be regulated by an inlet valve. The drums are brass lined, avoiding all chance of corrosion, and all valves are self-cleaning.



PHANTOM VIEW OF DUPLEX RETURN STEAM TRAP

The duplex return feature makes it possible to deliver water for boiler feeding in a constant flow, either with water passed through the heater, or by returns from the heating system. The design is such that no floats are required, nor are springs, levers or weights necessary, and the duplex feature permits one tank to be emptying while the other is filling. When one is filled and the other emptied, their positions are reversed, thus making the action continuous. This apparatus is made by the Duplex Steam Pump Co., Moffat Bldg., Detroit, Mich.

June 20 to 24, the Associated Advertising Clubs of the World will meet in convention in Chicago, the expected attendance being 10,000 business men. Convention meetings will be held in the Auditorium Theater, and various departmental meetings, such as retail advertisers, general advertisers, business papers, magazines, etc., in the Auditorium Hotel and Annex on the lake front.

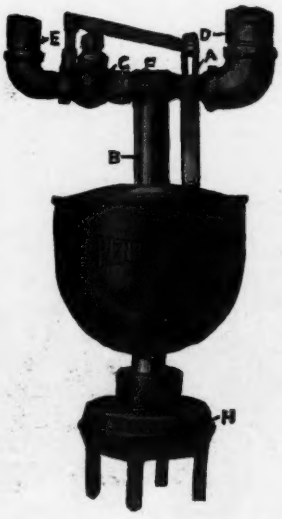
In addition to the business meetings, there will be an unusual program of entertainment, including a street pageant to be held on Monday evening. Tuesday and Wednesday evenings, a show will be staged at the Auditorium Theater, and for the ladies in attendance, there will be lake excursions, automobile trips and other interesting features.

An exhibition of the trade and technical publications will be an interesting feature of the convention, the details being even better arranged than were those of a similar exhibit held at the Toronto convention last year. Emphasis will be placed upon the value of the selected circulation of modern business publications to the advertiser.

Lifting Drainage to Sewer Level

BOILER rooms of many office buildings are below the level of the city sewers and all drainage, therefore, must be raised in order to be disposed of. The Penberthy Injector Co., Detroit, Mich., manufactures an automatic drainer for this purpose which operates with either water pressure or steam, starts and stops automatically with the rise and fall of the water and requires no attention.

The accompanying illustration shows the device; it is a Penberthy water pressure ejector of high capacity, automatically operated by a float-controlled, quick-opening-and-closing valve, C. This valve is never partially opened—it cannot leak, and allows the ejector to give its greatest efficiency by working to its full capacity. The float arms are slotted at A, where they connect to valve lever C, a form of construction which prevents the ejector from operating until the water has raised the float up to the highest point, and, as the water is ejected, they travel down the length of these slots before the weight of the float affects the valve. This allows the machine to work for longer periods and not so often, thus preventing considerable wear and the leakage of water.



PENBERTHY AUTOMATIC DRAINER

To enable the installation of this drainer in small holes or sumps, it is made as compact as possible. The float instead of being round, is flat on the top; it has more buoyancy and occupies less space than a round float of the same diameter. And to economize further on space, the float has been built around the suction pipe B, a patented feature having the added advantage of being rigid and overcoming all the trouble of the common loose float. The balance of the drainer is built directly above the float; this not only keeps the whole machine in as small a space as possible, but also keeps all working parts, with the exception of the strainer and float, above the water, thus preventing corrosion and the exterior parts becoming clogged by deposits of slime, dirt or sediment. It is stated that water troubles in buildings, boiler rooms, elevator pits, etc., can be taken care of automatically by this device.

Type "E" Stoker

IN this stoker, made by the Combustion Engineering Corporation, of New York, coal is fed by hand or chutes into the large hopper shown in Fig. 1, and conveyed under the fire by means of a reciprocating sliding bottom of the feed trough or retort running the full length of the stoker. The coal is delivered uniformly from front to rear by the auxiliary pushers, and as it rises in the trough is distributed to the sides of the furnace by means of moving bars. The burning fuel is constantly carried by the action of these bars to the dumping trays, placed along each side wall where the resulting ash or clinker is deposited and which are dumped by a single motion of the dump lever on the outside of the furnace.

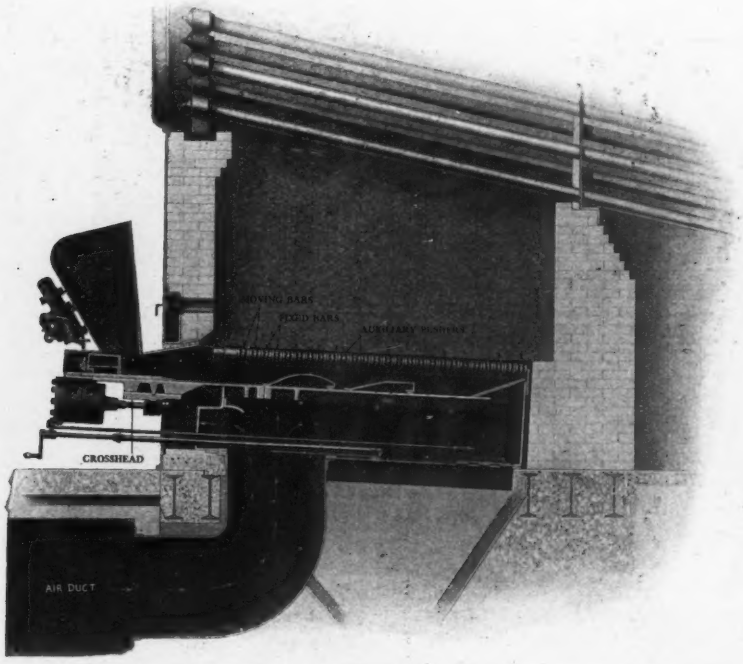


FIG. 1. LONGITUDINAL SECTION THROUGH CENTER OF RETORT

The sliding bottom is driven by a steam piston, the cylinder of which is bolted to the stoker frame under the hopper. The movement of this piston is transmitted to the sliding bottom through a rigidly-bolted crosshead, driven by the piston through a sleeve on the piston rod, fitting loosely in a yoke on the underside of the crosshead. The feeder block is fastened to the sliding bottom and forces the coal onto it, not only carrying the coal into the furnace, but forcing it to rise the full length of the retort.

As the coal rises in the retort, it is flooded onto the fire bars, which are arranged in pairs alternately moving and fixed. The moving bars work transversely to the

retort, the motion being horizontal at the inner or retort end and slightly inclined at the outer end, the extent of motion being about 1 in.

The movement of the bars is obtained through the agency of 2 helices and nuts located outside of the furnace. The helix nuts are bolted to the crosshead and reciprocate with it, causing the helices to rock to and fro, and with them the rocking bars.

On the upper side of the rocking bars is a rib which engages between 2 lugs cast on the underside of the moving fire bars; the movement of the rocking bars, therefore, causes the moving fire bars to move outward and inward with each stroke of the piston.

In addition to carrying the burning fuel to the sides of the furnace, the movement of the fire bars also conveys the clinker and ash down and onto the dump trays. One of the important features of this stoker is the distribution of the air, all of which enters the stoker through the opening in the bottom of the wind box.

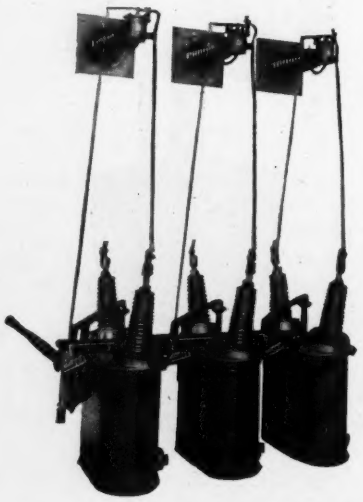
FIG. 2. CROSS SECTION OF TYPE "E" STOKER

After entering this wind box the air passes upward along each side of the retort and is discharged partly through the tuyere openings in the inside or retort end of the fire bars; the remaining air passes through the hollow fire bars, which are of box-like cross section, and is discharged into the auxiliary air boxes. From these chambers the air enters the fire through narrow openings between the fire bars.

In passing through and between the bars, the air cools them both inside and outside, thus greatly prolonging their life. The heat taken off the bars in this way raises the temperature of the air in the auxiliary air chambers to 300 or 400 deg. F. There are no openings in the tops of the hollow fire bars, and except through the tuyere openings no air can reach the fire until it has been heated by its passage through the fire bars.

New Series Trip for High Voltage Oil Switches

LOW-VOLTAGE current is usually employed to trip high voltage automatic oil switches on the occurrence of abnormal conditions against which the automatic features are intended to guard. Electrically operated switches are usually tripped by direct current; for tripping hand-operated switches, alternating current is generally used. In many cases, however, neither low-voltage direct-current or alternating-current is conveniently or cheaply available; and then, automatic protection is secured by the aid of a high-voltage series trip.



TYPE F, FORM K-21, TRIPLE-POLE, SINGLE-THROW, 45,000-V. OIL SWITCH WITH TRIPLE-POLE TIME LIMIT SERIES TRIP

For this service, the General Electric Co. has developed an arrangement representing considerable improvement on types of high-voltage series tripping devices heretofore in use. Its features are: accessibility of the working parts for inspection; cleaning or adjustment while in service without danger; calibration at the oil switch itself, and not at the insulator supporting the

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

A. S. Cameron Steam Pump Works

PRACTICAL ENGINEER

FRICTION LOSS IN POUNDS PRESSURE PER SQUARE INCH

For each 100 feet of length in different size clean iron pipes discharging given quantities of water per minute.

Gallons Discharged per Minute	Friction Loss in Pounds ¼ Inch	⅜ Inch	½ Inch	¾ Inch	1 Inch	1¼ Inch	1½ Inch	2 Inch	2½ Inch	3 Inch	3½ Inch	4 Inch	5 Inch	6 Inch	Gallons Discharged per Minute
5	24.6	3.3	.84	.31	.12										5
10	96.0	13.0	3.16	1.05	.47	.12									10
15		28.7	6.98	2.38	1.07	.27									15
20		50.4	12.5	4.07	1.82	.47	.12								20
25		78.0	19.0	6.40	2.86	.74	.19								25
30			27.5	9.15	4.07	1.05	.27	.07							30
35			37.0	12.04	5.46	1.42	.37	.09							35
40			48.0	16.1	6.98	1.82	.47	.12							40
45				20.2	8.75	2.28	.59	.15							45
50				24.9	10.8	2.80	.73	.18							50
60				36.1	15.5	4.07	1.05	.27							60
70					20.8	5.46	1.42	.36							70
80					26.8	6.98	1.82	.47	.12						80
90					33.4	8.75	2.28	.59	.15						90
100					40.5	10.6	2.76	.71	.18						100
125					61.2	16.1	4.18	1.08	.27						125
150						22.7	5.90	1.52	.39	.10					150
175						30.2	7.85	2.02	.52	.13					175
200						38.7	10.0	2.58	.66	.17					200
250							15.2	3.91	1.00	.25					250
300							21.3	5.48	1.40	.35					300
350							28.4	7.30	1.87	.47	.12				350
400							36.4	9.35	2.39	.60	.15				400
450							45.3	11.6	2.98	.75	.19				450
500								14.1	3.62	.91	.23				500
550								16.9	4.33	1.09	.28				550
600								19.9	5.10	1.28	.33				600
650								23.1	5.92	1.49	.38				650
700								26.5	6.80	1.71	.44				700
750								30.2	7.73	1.94	.50				750
800								34.2	8.75	2.20	.56				800
850								38.4	9.83	2.47	.63				850
900									11.0	2.76	.71				900
950									12.2	3.07	.78				950
1000									13.5	3.40	.87				1000
1100									16.4	4.12	1.05				1100
1200									19.5	4.90	1.25				1200
1300									22.9	5.75	1.47				1300
1400									26.6	6.67	1.70				1400
1500									30.5	7.66	1.95				1500
1600										8.71	2.22				1600
1700										9.83	2.50				1700
1800										11.0	2.80				1800
1900										12.2	3.12				1900
2000										13.5	3.45				2000
2100										14.9	3.80				2100
2200										16.3	4.16				2200
2300										17.8	4.54				2300
2400										19.3	4.93				2400
2500										20.9	5.33				2500
2600										22.5	5.74				2600
2700										24.2	6.17				2700
2800										25.9	6.61				2800
2900										27.7	7.06				2900
3000										29.5	7.52				3000
3100										31.4	8.00				3100
3200											8.49				3200
3300											8.99				3300
3400											9.50				3400
3500											10.0				3500
3600											10.6				3600
3700											11.1				3700
3800											11.7				3800
3900											12.3				3900
4000											12.9				4000
4100											13.5				4100
4200											14.1				4200
4300											14.7				4300
4400											15.3				4400
4500											15.9				4500
4600											16.5				4600
4700											17.2				4700
4800											17.8				4800
4900											18.5				4900
5000											19.2				5000
5100											19.9				5100
5200											20.6				5200
5300											21.3				5300
5400											22.0				5400
5500											22.7				5500
5600											23.4				5600
5700											24.2				5700
5800											24.9				5800
5900											25.7				5900
6000											26.4				6000

A. S. Cameron Steam Pump Works

PRACTICAL ENGINEER

RATIOS OF AREAS

For given diameters of steam pump, steam and water cylinders

Diameter of Water Cylinders	DIAMETER OF STEAM CYLINDERS 3	3½	4	5	6	7	8	9	10	12	14
⅝	23.04	31.36	40.97	64.01	92.16	125.45	163.85	207.37	256.00	368.64	501.76
¾	16.00	21.77	28.45	44.45	64.00	87.12	113.78	144.00	177.77	256.00	348.44
⅞	11.75	16.00	20.90	32.66	47.02	64.01	83.60	105.80	130.61	188.09	256.00
1	9.00	12.25	16.0	25.0	36.00	49.01	64.00	81.00	100.00	144.00	196.00
1⅛	7.11	9.68	12.65	19.76	28.44	38.73	50.57	64.00	79.01	113.77	154.87
1¼	5.76	7.84	10.24	16.0	23.04	31.37	40.97	51.85	64.0	92.18	125.46
1⅜	4.76	6.48	8.46	13.23	19.04	25.92	33.85	42.84	52.89	76.16	103.66
1½	4.00	5.44	7.11	11.12	16.00	21.78	28.45	36.00	44.45	64.00	87.12
1⅝	3.41	4.64	6.06	9.47	13.63	18.56	24.24	30.68	37.87	54.53	74.22
1¾	2.94	4.0	5.23	8.17	11.75	16.00	20.90	26.45	32.66	47.03	64.00
1⅞	2.56	3.48	4.55	7.11	10.24	13.94	18.21	23.04	28.44	40.96	55.75
2	2.25	3.06	4.00	6.25	9.00	12.26	16.00	20.26	25.00	36.00	48.09
2¼	1.78	2.42	3.16	4.93	7.10	9.67	12.63	15.98	19.73	28.42	38.68
2½	1.44	1.96	2.56	4.0	5.76	7.84	10.24	12.96	16.0	23.04	31.35
2¾	1.19	1.62	2.12	3.31	4.76	6.48	8.46	10.72	13.22	19.04	25.92
3	1.00	1.36	1.78	2.78	4.0	5.43	7.11	9.00	11.11	16.0	21.77
3¼	.85	1.16	1.51	2.37	3.4	4.64	6.06	7.67	9.46	13.63	18.55
3½	.73	1.00	1.31	2.04	2.94	4.00	5.23	6.61	8.17	11.76	16.00
3¾	.64	.87	1.14	1.78	2.56	3.48	4.55	5.76	7.11	10.24	13.93
4	.56	.77	1.00	1.56	2.25	3.06	4.00	5.06	6.25	9.00	12.25
4¼	.50	.68	.89	1.38	1.99	2.71	3.54	4.49	5.53	7.97	10.85
4½	.44	.61	.79	1.23	1.78	2.42	3.16	4.00	4.94	7.11	9.68
4¾	.40	.54	.71	1.11	1.60	2.17	2.84	3.59	4.43	6.38	8.68
5	.36	.49	.64	1.00	1.44	1.96	2.56	3.24	4.00	5.76	7.84
5½	.30	.40	.53	1.00	1.19	1.62	2.12	2.68	3.30	4.76	6.48
6	.25	.34	.45	.83	1.00	1.36	1.78	2.25	2.78	4.00	5.45
6½	...	.29	.38	.69	.85	1.16	1.51	1.92	2.37	3.40	4.64
7	...	.25	.33	.59	.73	1.00	1.31	1.65	2.04	2.94	4.00
7½	...	...	.28	.51	.64	.87	1.14	1.44	1.78	2.56	3.48
8	...	...	.25	.44	.56	.77	1.00	1.27	1.56	2.25	3.06
8½	...	...	...	.39	.50	.68	.89	1.12	1.38	1.99	2.71
9	...	...	...	.35	.44	.60	.79	1.00	1.23	1.78	2.42
9½	...	...	...	.31	.40	.54	.71	.90	1.11	1.60	2.17
10	...	...	...	.28	.36	.49	.64	.81	1.00	1.44	1.96
10½	...	...	...	.25	.33	.44	.58	.73	.91	1.31	1.77
11	...	...	...	...	.30	.40	.53	.67	.83	1.19	1.62
12	...	...	...	...	.25	.34	.44	.56	.69	1.00	1.36
13	...	...	...	...	...	.29	.38	.48	.59	.85	1.16
14	...	...	...	...	...	.25	.33	.41	.51	.74	1.00
15	...	...	...	...	...	...	.28	.36	.44	.64	.87
16	...	...	...	...	...	...	.25	.32	.39	.56	.76
17	...	...	...	...	...	...	...	.28	.35	.50	.68
18	...	...	...	...	...	...	...	.25	.31	.45	.60

A. S. Cameron Steam Pump Works

PRACTICAL ENGINEER

HEIGHTS IN FEET TO WHICH PUMPS WILL ELEVATE WATER

Steam pressure, 50 pounds per square inch at the pump. No allowance made for friction in pipes, etc.

Diameter of Steam Cylinders	DIAMETER OF WATER CYLINDERS 3 Inch	3½ Inch	3 Inch	3¼ Inch	4 Inch	5 Inch	6 Inch	7 Inch	8 Inch	9 Inch	10 Inch	10½ Inch	12 Inch	14 Inch	16 Inch	18 Inch	20 Inch
3½	230	147	102	75	58	37	34	38									
4	300	192	134	98	75	48	53	55	42								
5	469	300	209	153	117	75	82	85	65	45	33						
6	675	432	300	221	169	108	118	122	94	65	48	37					
7	920	588	408	300	230	147	161	166	128	88	65	50	42				
8		768	533	392	300	192	210	217	167	115	85	65	55	38			
9		972	675	496	380	243	266	274	211	146	107	82	69	48	37		
10			833	612	469	300	328	339	260	180	132	101	85	59	45	33	
11			1008	741	567	363	397	410	315	218	160	123	103	71	55	40	33
12				882	675	432	472	488	375	259	190	146	122	85	65	48	39
13				1034	792	507	554	572	440	304	223	172	144	100	77	56	46
14					918	588	642	663	510	352	259	199	166	116	89	65	53
15					1054	675	738	762	586	405	297	229	191	133	102	75	61
16						768	839	866	667	460	338	260	217	151	116	85	69
17						864	945	975	750	518	380	293	244	170	130	96	78
18						972	1062	1096	844	582	428	329	275	191	147	108	87
19						1080	1180	1218	938	647	475	366	305	212	163	120	97
20							1300	1340	1032	712	523	402	336	234	180	132	107
21							1420	1460	1125	776	570	439	366	255	196	144	116
22							1540	1590	1225	844	620	477	398	277	213	156	126

The maximum limit of piston speed depends upon the head pumped against.

A. S. Cameron Steam Pump Works

PRACTICAL ENGINEER

AREAS OF TWIST DRILL BORES

Gage No.	Dia. In.	Area Sq. In.	Gage No.	Dia. In.	Area Sq. In.
1	0.2230	0.03905	23	0.1540	0.01860
2	0.2210	0.03836	24	0.1520	0.01815
3	0.2130	0.03563	25	0.1495	0.01756
4	0.2090	0.03431	26	0.1470	0.01697
5	0.2055	0.03317	27	0.1440	0.01628
6	0.2040	0.03268	28	0.1405	0.01550
7	0.2010	0.03173	29	0.1360	0.01453
8	0.1990	0.03110	30	0.1285	0.01297
9	0.1960	0.03017	31	0.1200	0.01131
10	0.1935	0.02941	32	0.1160	0.01057
11	0.1910	0.02865	33	0.1130	0.01003
12	0.1890	0.02806	34	0.1110	0.00968
13	0.1850	0.02688	35	0.1100	0.00950
14	0.1820	0.02602	36	0.1065	0.00891
15	0.1800	0.02545	37	0.1040	0.00849
16	0.1770	0.02461	38	0.1015	0.00809
17	0.1730	0.02351	39	0.0995	0.00778
18	0.1695	0.02256	40	0.0980	0.00754
19	0.1660	0.02164	41	0.0960	0.00724
20	0.1610	0.02036	42	0.0935	0.00687
21	0.1590	0.01986	43	0.0890	0.00622
22	0.1570	0.01936	44	0.0860	0.00581

By Howard D. Yoder.

RATIOS OF AREAS

For given diameters of steam pump, steam and water cylinders

Diameter of Water Cylinder	DIAMETER OF STEAM CYLINDERS										
	16	18	20	22	24	26	28	30	32	34	36
¾											
⅞	455.09										
⅞	334.37										
1	256.0	324.00	400.00								
1⅛	202.27	256.00	316.05								
1¼	163.86	207.38	256.0	309.81							
1⅜	135.39	171.47	211.69	256.00							
1½	113.78	144.00	177.77	215.11	256.00						
1⅝	96.94	122.72	151.54	183.37	218.22						
1¾	83.60	105.79	130.61	158.05	188.10	220.71					
1⅞	72.82	92.16	113.78	137.67	163.85	192.29					
2	64.00	81.00	100.00	121.00	144.00	169.00	196.00	225.00	256.00		
2¼	50.56	64.00	79.01	95.60	113.78	131.56	154.87	177.77	202.27		
2½	40.96	51.84	64.00	77.44	92.16	108.16	125.44	144.00	163.84	184.97	
2¾	33.85	42.84	52.89	64.00	76.17	89.39	103.66	119.01	135.41	152.86	
3	28.44	36.00	44.44	53.77	64.00	75.11	87.11	100.00	113.77	128.44	144.00
3¼	24.23	30.67	37.87	45.83	54.54	64.00	74.24	85.22	96.96	109.46	122.72
3½	20.90	26.44	32.65	39.42	47.02	55.18	64.00	73.47	83.59	94.36	105.79
3¾	18.20	23.04	28.44	34.42	40.96	48.07	55.75	64.00	72.82	82.21	92.16
4	16.00	20.25	25.00	30.25	36.00	42.25	49.00	56.25	64.00	72.25	81.00
4¼	14.17	17.93	22.14	26.79	31.89	37.43	43.41	46.51	56.69	64.00	71.76
4½	12.64	16.00	19.75	23.90	28.44	33.33	38.71	44.44	50.56	57.08	64.00
4¾	11.34	14.36	17.73	21.45	25.53	29.96	34.75	39.89	45.38	51.24	57.44
5	10.24	12.96	16.00	19.20	23.04	27.04	31.36	36.00	40.96	46.24	51.84
5½	8.46	10.71	13.22	16.00	19.04	22.33	25.91	29.75	33.85	38.21	42.84
6	7.11	9.00	11.11	13.44	16.00	18.77	21.77	25.00	28.44	32.11	36.00
6½	6.06	7.66	9.46	11.45	13.63	16.00	18.56	21.30	24.23	27.36	30.67
7	5.22	6.61	8.16	9.87	11.75	13.79	16.00	18.37	20.90	23.59	26.44
7½	4.55	5.76	7.11	8.60	10.24	12.00	13.93	16.00	18.20	20.55	23.04
8	4.00	5.06	6.25	7.25	9.00	10.56	12.25	14.06	16.00	18.06	20.25
8½	3.54	4.48	5.53	6.69	7.97	9.35	10.85	12.45	14.17	16.00	17.92
9	3.15	4.00	4.93	5.98	7.11	8.34	9.67	11.11	12.64	14.27	16.00
9½	2.83	3.59	4.43	5.36	6.38	7.49	8.68	9.97	11.34	12.88	14.36
10	2.56	3.24	4.00	4.84	5.76	6.76	7.84	9.00	10.24	11.56	12.96
10½	2.32	2.94	3.63	4.39	5.22	6.13	7.10	8.16	9.29	10.48	11.75
11	2.11	2.67	3.30	4.00	4.76	5.58	6.47	7.43	8.46	9.55	10.71
12	1.77	2.25	2.77	3.36	4.00	4.67	5.44	6.25	7.11	8.02	9.00
13	1.51	1.91	2.37	2.86	3.40	4.00	4.63	5.32	6.06	6.83	7.66
14	1.30	1.65	2.04	2.46	2.93	3.44	4.00	4.59	5.22	5.89	6.61
15	1.13	1.44	1.77	2.13	2.56	3.00	3.48	4.00	4.55	5.13	5.76
16	1.00	1.26	1.56	1.89	2.25	2.64	3.06	3.51	4.00	4.51	5.06
17	.88	1.12	1.38	1.67	1.99	2.34	2.71	3.11	3.54	4.00	4.48
18	.79	1.00	1.23	1.49	1.77	2.08	2.41	2.77	3.15	3.56	4.00

A. S Cameron Steam Pump Works

FRICTION LOSS IN POUNDS PRESSURE PER SQUARE INCH

For each 100 feet of length in different size clean iron pipes discharging given quantities of water per minute.

Gallons Discharged per Minute	5 Inch	6 Inch	8 Inch	10 Inch	12 Inch	14 Inch	16 Inch	18 Inch	20 Inch	24 Inch	30 Inch	Gallons Discharged per Minute
	Friction Loss in Pounds											
250	.65	.26	.07	.03	.01	.017	.009	.005	....	....	....	250
500	2.70	.96	.25	.09	.04	.062	.036	.020	.012	.005	.002	500
750	5.40	2.21	.53	.18	.08	.135	.071	.040	....	....	....	750
1,000	9.60	3.88	.94	.32	.13	.234	.123	.071	.042	.020	.006	1,000
1,250	....	....	1.46	.49	.20	.362	.188	.107	.063	.027	....	1,250
1,500	....	....	2.09	.70	.29	.517	.267	.150	.091	.047	.012	1,500
1,750	....	....	....	.95	.38	.697	.365	.204	.122	.057	.016	1,750
2,000	....	....	....	1.23	.49	.910	.472	.263	.158	.067	.022	2,000
2,250	....	....	....	....	.63	....	.593	.333	.244	.102	.035	2,250
2,500	....	....	....	....	.77	....	.730	.408	.348	.146	.048	2,500
3,000	....	....	....	....	1.11	....	....	.585	.472	.196	.065	3,000
3,500	....	....	....	....	....	....	....	....	.612	.255	.083	3,500
4,000	....	....	....	....	....	....	....	....	....	.323	.105	4,000
4,500	....	....	....	....	....	....	....	....	....	.396	.131	4,500
5,000	....	....	....	....	....	....	....	....	....	....	....	5,000
6,000	....	....	....	....	....	....	....	....	....	....	....	6,000
7,000	....	....	....	....	....	....	....	....	....	....	....	7,000
8,000	....	....	....	....	....	....	....	....	....	....	....	8,000
9,000	....	....	....	....	....	....	....	....	....	....	....	9,000
10,000	....	....	....	....	....	....	....	....	....	....	....	10,000

A. S. Cameron Steam Pump Works

AREAS OF TWIST DRILL BORES (CON'D)

Gage No.	Dia. In.	Area Sq. In.	Gage Letter	Dia. In.	Area Sq. In.
45	0.0820	0.00528	E	0.250	0.0491
46	0.0810	0.00515	F	0.257	0.0519
47	0.0785	0.00484	G	0.261	0.0535
48	0.0760	0.00454	H	0.266	0.0556
49	0.0730	0.00419	I	0.272	0.0581
50	0.0700	0.00385	J	0.277	0.0603
51	0.0670	0.00353	K	0.281	0.0621
52	0.0635	0.00317	L	0.290	0.0661
53	0.0595	0.00278	M	0.295	0.0683
54	0.0550	0.00238	N	0.302	0.0716
55	0.0520	0.00212	O	0.316	0.0784
56	0.0465	0.00170	P	0.323	0.0819
57	0.0430	0.00145	Q	0.332	0.0866
58	0.0420	0.00139	R	0.339	0.0903
59	0.0410	0.00132	S	0.348	0.0951
60	0.0400	0.00126	T	0.358	0.1007
Gage Letter			U	0.368	0.1064
			V	0.377	0.1116
A	0.234	0.0430	W	0.386	0.1170
B	0.238	0.0445	X	0.397	0.1238
C	0.242	0.0460	Y	0.404	0.1282
D	0.246	0.0475	Z	0.413	0.1340

By Howard D. Yoder.

DISCHARGE OF 1⅛ IN. SMOOTH HOSE NOOZLES

Hydrant pressure required — Height and distance of jet

		INDICATED PRESSURE BY GAUGE ATTACHED AT BASE OF PLAY PIPE AND SET LEVEL WITH END OF NOZZLE	EXTREME HEIGHT OF JET		EXTREME HORIZONTAL DISTANCE REACHED BY JET		GALLONS PER MINUTE DISCHARGED	POUNDS PRESSURE REQUIRED AT HYDRANT (OR STEAMER) WHILE STREAM IS FLOWING TO MAINTAIN PRESSURE AT BASE OF PLAY PIPE, AS PER FIRST COLUMN, THROUGH VARIOUS LENGTHS OF 2½ INCH ORDINARY BEST QUALITY RUBBER LINED HOSE—INSIDE SMOOTH				
			Average of highest drops, vertical jet, still air	Maximum limit of height as good effective fire stream with moderate wind	Average extreme drops at level of nozzle with still air	Maximum limit of distance as good effective fire stream with moderate wind		50 ft. length	100 ft. length	200 ft. length	200 ft. length	400 ft. length
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		lbs.	*ft.*	*ft.*	*ft.*	*ft.*		*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Unusually strong streams	Excellent	5	11		19		84	6	7	9	10	12
		10	22	18	39	22	119	12	14	17	20	24
		15	32	27	59	31	146	19	21	26	31	35
		20	43	36	80	38	168	25	28	34	41	47
	Good	25	54	44	99	44	188	31	35	43	51	59
		30	64	52	115	50	206	37	42	52	61	71
Ordinary fire streams		35	74	59	130	54	222	43	49	60	71	82
		40	84	65	142	59	238	50	56	69	81	94
		45	94	70	152	63	252	56	63	77	92	106
	Fair	50	104	75	162	66	266	62	70	86	102	118
		55	113	80	170	69	279	68	77	95	112	130
		60	122	83	178	72	291	74	84	103	122	141
Feeble streams		65	130	86	185	75	303	81	91	112	132	153
		70	136	88	191	77	314	87	98	120	143	165
		75	142	90	197	79	325	93	105	129	153	177
		80	146	92	203	81	336	99	112	138	163	188
		85	150	94	209	83	346	106	119	146	173	200
		90	153	96	214	85	356	112	126	155	183	212
		95	156	98	219	87	366	118	133	163	194	224
		100	158	99	224	89	376	124	140	172	204	236

N. S. Hill, Jr., Am. W. W. Ass'n.

series tripping solenoid; and the use of a new type of solenoid, which consists of but a few simple and rugged parts that need practically no attention whatever after installation.

The solenoid plunger is connected to the tripping mechanism of the oil switch by a wooden rod. Calibration, that is, change in current tripping values, is accomplished by a movable weight located near the operating mechanism of the switch at a considerable distance from the high-voltage current.

This type of series trip is furnished for instantaneous or inverse time limit operation. Time delay is obtained by means of a dashpot mounted on the tripping mechanism at the switch.

News Notes

ON JUNE 21, 22 and 23, a meeting of the Boiler Makers of the country will be held at the Fort Pitt Hotel, Pittsburgh, to take action in regard to the methods for introducing the Boiler Code recently adopted by the A. S. M. E. and the boiler makers of the country, and having it written into the laws of the various states. Effort is being made to secure the largest possible attendance, so that the Uniform Standard Specifications may be given the widest possible publicity, and the largest possible support.

JOHN F. HALE has resigned from the position formerly held by him with the Warren-Webster Co., of Camden, N. J., and has associated himself with the Consolidated Engineering Co., of Chicago, where he will be permanently located.

JOHN SABIN has been elected General Manager of the Nashua Machine Co., and has removed to Nashua, N. H., where the sales offices of the Bundy steam traps will in future be located. The Boston offices will be maintained for the handling of New England business, and will be in charge of E. M. Stevens. The promotion of Mr. Sabin is well deserved, and is welcome news to all of his many friends.

FRANK H. WILLIAMS is retiring from the organization of the Sperry & Barnes Co., of New Haven, Conn., where for 7 yr. he has been chief engineer and master mechanic, to take a similar position with John Morrell Co., Sioux Falls, S. D.

THE ANNUAL MEETING of the Stockholders of the Joseph Dixon Crucible Co., was held at the company's office in Jersey City on Monday, April 19, 1915. There were present a large attendance of stockholders who expressed their satisfaction with the present management and re-elected the former Board of Directors for the ensuing year. The vote recorded was the largest ever represented at an annual election,—19,519 shares out of a possible 20,000.

The following named gentlemen are the Directors elected: George T. Smith, Robert E. Jennings, George E. Long, E. L. Young, William G. Bumsted, J. H. Schermerhorn and Harry Daily. The officers elected by the Board of Directors are: President, George T. Smith; Vice President, George E. Long; Treasurer, J. H. Schermerhorn; Secretary, Harry Dailey, and Asst. Secy. and Asst. Treas., Albert Norris.

Book Reviews

SANITARY REFRIGERATION AND ICE-MAKING, by J. J. Cosgrove, 300 pages, 100 drawings, 5½ by 8½ in., in cloth binding; Philadelphia, 1914. Price, $3.50.

This book has been carefully prepared for the use of the man who has to install and operate refrigerating and ice-making plants, and for the architect and mechanical engineer who is concerned with the design of a plant where such machinery forms part of the equipment. It starts with the principles of refrigeration, and the properties of the materials used as refrigerants, then deals with the details of compression systems, giving a section each to the compressor, the condenser, the receiver, expansion valves and coils, refrigeration pipes, ammonia fittings, the insulation of cold storage rooms and of pipes, and the refrigeration required for storage rooms. The use of brine circulation is also taken up, the details of the absorption system, and of cold air circulation. Portable outfits for ice-making and refrigeration are briefly described, and special treatment is given of refrigeration in breweries, plate and can ice-making and excavating by the freezing process.

The book is free from mathematics, but contains many useful tables of properties of ammonia and steam, value of insulating materials, properties of different brines, and dimensions of piping systems which are needed in the laying out and handling of plants. The drawings are particularly well prepared to show clearly details of construction and methods of arrangement.

While covering the ground, the book is concise and clear, so that it gives the necessary information in the smallest possible space, and with a minimum expenditure of time. The press work is particularly attractive, and the book is especially pleasing to read and to handle. It gives a clear idea of proper proportions of the plant, and proper arrangement of machinery, but deals only briefly with the details of operation.

THE FIRST VOLUME of the Universal Safety Standards, Machine Shop and Foundry, by Carl M. Hansen, M. E., Chief Engineer of the Workmen's Compensation Service Bureau, New York City, Member of American Society of Mechanical Engineers, is a handbook of concrete examples of safeguarding and rules for practice in machine shops and foundries.

This is the first one of a series of books which will be issued under the direction of the Workmen's Compensation Service Bureau, in the course of the next 2 or 3 yr. They will all bear the endorsement of the leading compensation and liability insurance companies and these standards will be exclusively used in fixing the rates for workmen's compensation insurance under the Universal Analytic Schedule.

The author strikes the keynote of industrial safety when he lays down the principles of safeguarding in such a way as to make one realize that he is fully capable of handling this problem. In fact, these principles of safeguarding may be compared to the axioms of geometry—they are so self-evident.

To reduce the cost of production and effect a saving in operation, accident prevention is one of the most prolific fields. Employers and others interested in safety

need authoritative information on the methods of assuring safety which will meet the requirements of the rulings of their insurance companies. In order to supply this demand, safety must be standardized. The Workmen's Compensation Bureau has seen fit to adopt Universal Safety Standards as its minimum requirements for industrial safety, because the book represents, in its opinion, the ideal condition for which they are constantly striving. These Standards were prepared with the aid of 80 engineers working under Mr. Hansen's direction and with the advice of and contributions from the leading industrial organizations in the country.

These Standards have been quoted so freely by the different State Labor Commissions that they now represent the basis of the safety laws in practically every compensation state in the Union, and this book is the means of familiarizing oneself with the basic standards of accident prevention. It is a standard handbook on safety engineering, showing conditions ordinarily found in machine shops and foundries with proper safeguards applied, treating these conditions with plain, brief specification and illustrating with drawings which show at a glance what is needed.

The book is purely to show what is necessary for safety.

The Workmen's Compensation Bureau is an association of 20 of the leading stock casualty insurance companies, its principal work being the determination of correct workmen's compensation and liability insurance rates. This system is now being applied in 13 states and last year 20,000 plants were merit-rated, having 1,200,000 employes and with a payroll of $700,000,000. The cost of installing safety devices in general is made up in the savings on insurance premiums. As part of this system, it has become necessary to standardize safety as a basis for rate reduction, and this volume, Machine Shop and Foundry, is the result.

The volume is attractively bound, in limp seal leather, 312 pages, indexed. Price, $3.

Catalog Notes

DIAMOND POWER SPECIALTY Co.'s recent publications include the following:

Making Heat Produce, which illustrates types of mechanical soot blowers; a pamphlet explaining advantages of the Diamond single end soot blower for hollow staybolt boilers; a third pamphlet, relating to the Diamond front end soot blower for return tubular boilers; a fourth, entitled Cutting the Cost of Producing Steam.

These pamphlets will be sent to those interested who address the company at Detroit, Mich.

THE LAGONDA MFG. CO., of Springfield, Ohio, has just issued a new 12-page catalog entitled, "Lagonda Locomotive Arch Tube Cleaners." This catalog covers the subject of scale removal from the arched tubes of locomotive water arch furnaces and describes the specially designed cleaner for this purpose. A copy may be had on request.

THE MOST RECENT bulletin of American Blower Co., Detroit, Mich., No. 25, Series 4, illustrates various installations of the Sirocco heating, ventilating, cooling and purifying systems.

THE GENERAL ELECTRIC CO. has just issued Bulletin No. 43,900, describing that company's Combined Unit Series Mercury Arc Rectifier Outfits. This outfit is designed to convert alternating into direct current for the operation of series luminous arc lamps. The various devices composing the outfit are so arranged as to require a minimum amount of space, simplified connections and afford the greatest safety to the attendant. These sets are made in 25, 50 and 75-light sizes, for 25 and 60 cycles, 2200 v. primary, and 4, 5 and 6.6 amp. secondaries. The bulletin contains dimension and connection diagrams, and describes the construction of the outfit in detail.

BULLETIN 17 of C. H. Wheeler Mfg. Co., Philadelphia, Pa., deals with the company's Multiflex patent atmospheric exhaust relief valve.

A BOOKLET relating to Cyclone hoists, made by The Chisholm-Moore Mfg. Co., Cleveland, O., was recently received.

RETURN TUBULAR BOILERS manufactured by E. Keeler Co., Williamsport, Pa., are described and illustrated in a 45-page catalog just issued by that company.

SCRANTON DUPLEX piston pumps are described, with directions for setting and operating them, in Bulletin No. 101 of The Scranton Pump Co., Scranton, Pa.

REVISIONS AND ADDITIONS applying to the 1915 Walworth Catalog are contained in a circular which is being sent out by Walworth Mfg. Co., of Boston.

HOW TO MAINTAIN Compressor Efficiency, the new Bulletin R. A., descriptive of Richards unloaders for air compressors, is being sent out by Yarnall-Waring Co., Chestnut Hill, Philadelphia.

CHIMNEYS constructed by The M. W. Kellogg Co., of New York, are the subject of a circular illustrating some of the uses to which these chimneys have been applied.

NONPAREIL high pressure covering for high pressure and superheated steam lines, boilers and other heated surfaces, is the subject of a new folder from Armstrong Cork & Insulation Co., Pittsburgh, Pa.

A 16-PAGE BULLETIN recently issued by the Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis, Mo., describes the Type B, vertical, 4-cylinder, single-acting, 4-stroke cycle, enclosed crank case, medium speed Diesel engine with 3-stage air compressor integral.

KERR TURBINE CO., Wellsville, N. Y., is distributing Bulletin No. 53, "Economy" Exhaust Steam Turbines, which describes and illustrates typical installations and explains the conditions under which exhaust turbines can be made to produce large increase in power output practically without other expense than the cost of the turbine installation. A copy of this bulletin will be mailed upon request.

INGERSOLL-RAND CO., Easton, Pa., has issued Form 3015, "Portable Air Compressors," illustrated, 32 pp., 6 by 9 in. This is a complete treatise on the subject of portable air compressing outfits which have been developed expressly for the contractor, mine oper-

ator, factory manager and others employing air tools in connection with work of a temporary or semi-permanent character. A list of bulletins describing in detail each particular line of portable compressors is given, together with catalogs of the various pneumatic tools and equipment mentioned throughout the catalog.

Form 4032, "Jackhamer Mounting, Type JM-6," illustrated, 4 pp., 6 by 9 in., covers drill mounting especially adapted to accommodate the "Jackhamer" with or without the water feed, for such flat hole work as drifting and underhand stoping in metal mines where shallow holes are required, for breaking down coal and driving gangways in coal mines.

Copies of these bulletins will be sent free on request.

McNAB & HARLIN Mfg. Co., 55 John St., New York, has recently issued a booklet describing its steel valves and fittings with monel metal and nickel alloy trimmings, for high pressure and superheated steam service.

BULLETIN L from Elliott Co., Pittsburgh, Pa., illustrates and explains the operation of several types of reducing valves made by the company.

A bulletin describing the Twin oil strainer, with vertical and horizontal sectional views, was also recently published.

VOLUME 6, NO. 5, of the Official Publications of Cornell University gives the announcement of the graduate school for 1915-16 which covers information in regard to admission to the graduate school, the advance degrees which may be secured by graduate study, the different subjects in which the courses may be taken, the fees required, and fellowships available.

FROM FORT WAYNE Electric Works of General Electric Co. have come the 1915 index of bulletins, and bulletins on the following subjects: No. 45,201—Type A Transformers of Large Capacities; No. 46,100—Type M Demand Indicators, designed to be mounted in place of the regular watthour meter register to furnish information in regard to the maximum demand for energy, as well as the total number of kilowatthours used; No. 46,101—Type P Demand Indicators, which, used in connection with watthour meters, register the energy consumption and make a simultaneous record of the time of day at which the various amounts of energy were consumed; No. 48,100—Commutating Pole Direct-Current Crane and Hoist Motor.

AMONG PUBLICATIONS recently issued by the Westinghouse Electric & Mfg. Co. are the following:

Current Limiting Reactance Coils, Leaflet 3751, describes the construction and purpose of this type of apparatus, which has recently come into prominent use owing to the increased capacities of the generating units, illustrating both the completed and the construction stages. This leaflet gives in a very brief, concise form the purpose of the reactance coil, describing the manner in which it is built.

How Electric Power Helps Manufacturers, Folder 4226, explains some of the many advantages to be gained by the manufacturer from the use of electric power. A number of illustrations of the application of electric power to the different industries are shown.

For Better Projection, Folder 4205, describes Westinghouse Cooper Hewitt Rectifiers for moving picture service, showing the advantages of direct current for this class of work, and describing the rectifier and its operation.

The Small Motor That Makes Sewing Such Easy Work, Folder 4152-A, shows the advantages to be gained by the seamstress from using the electric motor. Illustrations are given showing the method of mounting the different types.

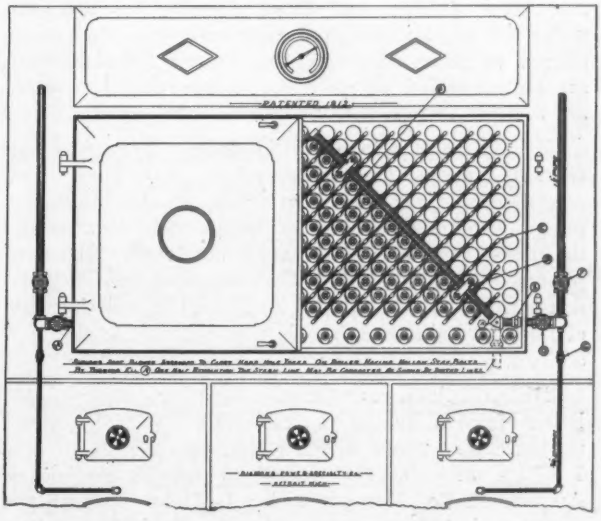
Electric Breakfast Set, Folder 4266-A, gives some definite data on cooking breakfast by means of the Westinghouse Toaster Stove, and Coffee Percolator. The percolator, toaster stove and radiant toaster are also described and illustrated.

ERRATA TO ACCOMPANY Bulletin No. 40,400, Belt-Driven Alternators, Form PB, is being sent out by General Electric Co.

Trade Notes

THE INLAND STEEL CO., Chicago Heights, Ill., have replaced the double end type of soot blowers which they have been using, with modern "Diamond" single end soot blowers, manufactured by the Diamond Power Specialty Co., Detroit, Mich.

It is interesting to note the wonderful improvement that has been made in soot blowers for hollow staybolt boilers. The old double type had to be operated from front and rear of the boiler by from 3 to 5 valves. If these valves were not operated in just the proper rotation, the inevitable result was that the soot was piled up in the center of the boiler instead of being blown out.



The new single end blower is all in the front of the boiler. The operation is simple—turning on the steam is all that is necessary. Further, the single end blower does not have to be removed to clean or repair the boiler tubes.

The illustration shows the "Diamond" single end blower installed on a hollow staybolt boiler: A, header; B, clamp attached to crab bolt; C, jet; D, auxiliary; E, union; F, main valve; G, drain; H, steam inlet.

GUNTHER WRIGHT MACHINE Co., Ownesboro, Ky., has been succeeded by the Wright Machine Co., of the same city, with capital of $150,000, and commenced business on May 1st, with the manufacture of gas engines, excavating machines, and wet dredge machines, equipped with both steam and oil engines. John S. Wright is the president.

BEGINNING MAY 1ST, the facilities of the Mitchell Vance Co. will be combined with those of the H. W. Johns-Manville Co., in the advancement of good design and manufacture of lighting fixtures. Mitchell Vance Co. will give its entire effort to the development, design and manufacture of lighting equipment, while the H. W. Johns-Manville Co. will take the sole agency for this product, and will attend to the marketing, through its large organization and branch houses.

This brings into the hands of the Johns-Manville Co., 3 great divisions of lighting effort. For concentrated, localized and special illumination, the Frink and J-M Linolite systems; for esthetic and commercial lighting equipment, the Mitchell Vance products, and on the study of special lighting problems, as well as installation service, the Construction Department of the Johns-Manville Co. throughout the United States and Canada. After May 15 the show rooms will be at 294 Madison Ave. near 41st St., and adjoining the Johns-Manville building in New York City.

GIANT PNEUMATIC TIRES for motor trucks are now being put into service by the Goodyear Tire & Rubber Co., as a departure from solid tires. These pneumatics are built on the same lines as automobile tires, but with more wires in the bead to hold the greater pressure and give perfect seating, and with more plies of fabric and thicker tread. They are sold under the regular Goodyear guarantee, with regard, of course, to reasonable care and proper inflation, and are recommended in place of dual pneumatics which are difficult to inflate so as to give equal wear.

THE PEERLESS RUBBER MFG. CO. has moved from 16 Warren St. to 31 Warren St., New York. The new location gives more floor space, which enables the company to meet with greater dispatch and convenience the demands of a rapidly expanding trade. The new premises are fitted throughout in a modern and complete manner. The company will be pleased to welcome any of its old "Rainbow" friends who may call at the new address.

BELOW ARE recent engine shipments made by the Bruce-Macbeth Engine Co., Cleveland: 1 100-hp. natural gas engine to the Fedders Mfg. Co., Buffalo, N. Y.; 1 60-hp. artificial gas engine to the Knickerbocker Amusement Co., Detroit, Mich.; 1 350-hp. natural gas engine and steam process to the Mansfield Milling Co., Mansfield, Ohio; 1 150-hp. natural gas engine to the Galion Iron Works & Mfg. Co., Galion, Ohio; 1 125-hp. natural gas engine to the Setter Bros. Co., Cattaraugus, N. Y.; 2 90-hp. natural gas engines to the Brookville Glass & Tile Co., Brookville, Pa.; 1 150-hp. natural gas engine to the Dunn-Taft Co., Columbus, Ohio; 1 150-hp. natural gas engine to the Fostoria Glass Co., Moundsville, W. Va.—the fourth Bruce-Macbeth engine ordered by this company.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

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All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,000

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As assistant engineer, experienced; I. C. S. student; best references; strictly sober, hold first class license; will consider small salary if advanced as merite. Address Robert Pieper, Bloomington Prairie. Minn. 5-1-1

POSITION WANTED—By young man, age 21, as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 4-1-3

POSITION WANTED—As engineer in a small plant or assistant in medium sized plant. Experienced with steam a.c. and d.c. machines. Member N. A. S. E. Strictly sober. Indiana preferred. Address G. A. Van Horn, La Fayette, Ind. 4-15-2

POSITION WANTED—Expert hydraulic and pumping engineer, six years' practical experience, technical graduate, desires position as Sales Manager or Assistant of pump concern or branch. A-1 references. Employed. Married. Address Box 395, Practical Engineer, Chicago, Ill.

POSITION WANTED—Man 39 years old, long experience with Elec. Light and Water Works plants. Five years manager on plant. Strictly sober. Best references. Wants position as manager plant. Texas or Oklahoma preferred. Address C. X., 809 Austin Ave., Brownwood, Texas.

POSITION WANTED—By engineer in medium sized power plant, or large coal mine. Have Illinois license; 7 years' experience with steam engines and boilers. Some experience with electricity. Good habits. References. 24. Illinois preferred. Address W. E. Rohline, Box 224, Farmington, Ill.

Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Calif.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Calif.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

WANTED—Representative to cover territory more thoroughly. Boiler room necessities. Liberal commissions. Old established house. Apply by letter. H. F. Maurel, 534 W. 22nd St., New York City. 4-1-3

WANTED—Engineer to sell automatic water regulators for steam boilers; can act as local agent; must be able to install. Eckel Hydrostat Co., 460 Mt. Elliott Ave., Detroit, Mich. 4-15-3

Help Wanted

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Sales Engineer. Successful concern, established eighteen years, highest standing in its line in the United States, wants a Sales Engineer. Only first-class salesman having had experience in engineer lines considered. Our product a necessity in every boiler plant. Price averages $250 per boiler. Sold on absolute guarantee. Exclusive territory allotted. Cash advances on trial orders will finance you if you have the ability. Positively give details about yourself in first letter. All correspondence held strictly confidential. Address Box 391, Practical Engineer, Chicago, Ill. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

For Sale

FOR SALE—Machinery. All sizes new and second-hand Pulleys, Belting, Shafting, Hangers, Couplings, Pillow Blocks, Collars, etc. Passman Bros., 28 and 30 So. Green St., Chicago, Ill. 3-15-6

MOTORS FOR SALE—Special type new guaranteed motors, 6¼-hp., 110-60 a.c., 2 1-hp. and 2 2-hp. 220-110-60 o.c. Also 2-hp., 3-hp. and 5-hp. 2 and 3-phase motors and direct current motors in sizes as large as 30 hp. A number of small generators, 5 light and larger. Fidelity Electric Co., Department "P," Lancaster, Pa. 5-1-2

FOR SALE—Grobert Swiss Files are the standard of excellence in files, and have been for over 100 yr. We send, postpaid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y.

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

A. P. CONNOR, consulting electrical and mechanical engineer, attorney-at-law and solicitor of patents and trademarks, 121 Carroll St. S. E., Washington, D. C. tf.-x.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

CHICAGO'S PROSPERITY PARADE

All hail to Chicago ! ! !

"When she starts anything," said a non-resident of the Great Central Market, "she usually makes a good finish of it."

This statement was amply verified by the recent Prosperity Parade.

"I Will" was the motto and spirit dominating the occasion.

At a given signal from a window high up in the city hall, the great parade, 12 miles long, began to move forward.

Nearly every industry and profession in the City of Chicago was represented in that one great column.

Pyramids of oranges, apples, lemons and pineapples on gorgeously decorated floats were in the long marching line.

A college of beauty culture vied with a firm advertising sausage.

Meat products from the packing firms of the Union Stock Yards lavishly displayed in floats passed between the lines of humanity that fringed the streets in tens of thousands.

Athletic Clubs with track teams in their customary B. V. D.'s, Training Schools, and public utilities contributed largely to the demonstration.

A constant shower of oranges, apples, raisins, soap, matches, peanuts, carnations, roses, etc., rained upon the spectators.

The brain and brawn of the great city of Chicago represented in one concerted movement for uplift and betterment were visioned in that great cavalcade, the like of which was never equaled in the history of any city.

It was more than a mere holiday crowd—more than a Mardi Gras display.

It was the advent of Prosperity.

Men and women in every walk of life—in every trade and every employment were talking prosperity.

Big business was there, represented by magnificent turnouts, not arrogant nor haughty, but like all the rest, exuding optimism and the spirit of co-operation and helpfulness.

Large delegations from all over Illinois came to view the spectacle.

Bells rang, whistles blew, bombs boomed, flags waved, crowds cheered, bands played, but above all this din and bedlam there was that one ceaseless cadence:—"Prosperity!" "Prosperity!"

Chicago has struck the key note for prosperity enthusiasm and must be credited with being the generating dynamo of optimism for the whole country.

Elgin, Lyons, Aurora and other towns are planning prosperity celebrations.

Let the whoops multiply and resound from New York to San Francisco.

Prosperity is coming and coming fast.

The mills are belching forth smoke, the factory doors are thrown wide open, the bench and the forge are again serving the demands of commerce, they are wearing and not rusting out, and Prosperity is advancing step by step, in firm and rapid strides.

Do you want your share of it?

Then buy what you need today and buy the advertised products to protect yourself and help the advertiser who is Prosperity's Greatest Booster.